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A Giant Marine Gastropod Mollusc

ONCE AGAIN the intrepid staff photographer of Power Plant Engineering (you remember, the man who took the picture of lightning striking the Empire State Building and of many other interesting and unusual events) was on the job when this giant gastropod mollusc or sea snail was hauled out of the Atlantic ocean onto the dock, as shown in the above photograph.

It was early morning and a fog lay over the harbor. The horizon line was extremely dusty, because the man whose duty it was to stand on the tower at the right and sweep the horizon with his glass had not yet reported for duty. Despite this handicap, however, our intrepid artist of the lens obtained this splendid shot.

This rare species of *Metampus lineatus* represents the family *Auriclidae* and is one of the few species inhabiting the salt marshes along the coast but seldom seen in such great size.

The photographer sent this picture from Newport News, Va., and we have wondered, after studying the picture, whether it could possibly have been confused with a picture of the scroll case of a 92,000-hp. hydraulic turbine built by Newport News Shipbuilding & Drydock Co. That turbine, designed for installation at Dnieprostroy, in the land of snow and ice—

But speaking of ice, which has other uses than filling up the little cubiculated boxes in our refrigerators, you will find on page 1069 of this issue some data on how to prevent its formation at flashboards of dams.

Moores Park Completed By 20,000-kw. Unit No. 4

Municipal Power Plant Serving City of Lansing, Mich., Now Has Total Generating Capacity of 65,000 kw. in Four Units, the Latest of 20,000 kw. Capacity. Boiler House Addition Contains Four New Stoker-Fired Steam Generating Units Making 450-lb. 700-deg. Steam for 55,000 kw. of the Total Capacity, Leaving Former 250-lb. Boilers for Reserve and Industrial Plant Supply. Increase of Steam Pressure and Temperature, Centralized Boiler Controls and Other Features Give the Entire Plant the Benefit of Developments in Steam Generation Since First Unit was Installed in 1921

MOORES PARK STATION, supplying electric power for the municipal system of the City of Lansing, Michigan, has recently been completed by the placing in service of a new 20,000-kw. turbine-generator unit and an addition to the boiler house containing four stoker-fired bent-tube boilers which can supply steam for 55,000 kw. capacity of a total station capacity of 65,000 kw., leaving the former boiler house available for the 10,000 kw. reserve and for supplying 60,000 lb. of steam an hour to a nearby industrial plant.

The station now contains four steam turbine generator units, one of 10,000 kw. capacity, one of 15,000 kw. and two of 20,000 kw. This makes it the second largest municipal power plant in the country serving a system that provides complete municipal, industrial and domestic power and light services to a city and the third largest municipal steam plant in the country. The Board of Water & Light Commissioners of Lansing also operates a district heating system, supplied from two older steam stations in the downtown district but since the Moores Park Station is not connected in any way with this system, the following description will discuss only the newest units at Moores Park. Test data on the No. 3 20,000-kw. generating unit were presented in the February 15, 1928, issue of Power Plant Engineering.

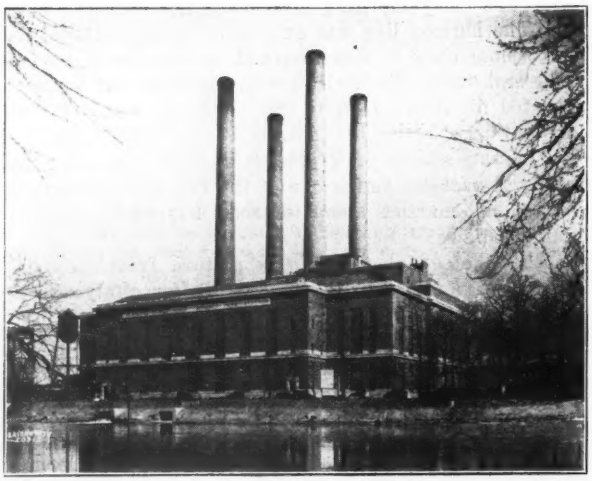


FIG. 1. MOORES PARK STATION AS IT APPEARS COMPLETED

Installation of No. 4 unit brings to a culmination a program of development begun in 1921 and carried out over a period of 10 yr. to keep pace with the growing needs of the city. The station is now completed because at this site the entire available supply of condensing water from Grand River is now utilized. If more generating capacity is needed in the future, the city will consider the erection of a new plant at another site.

General Layout of Plant

General arrangement of Moores Park Station provides for a turbine room, Fig. 6, running the length of the station on one side and the boiler rooms on the other side, with a centralized boiler control room, Fig. 7, between the new boiler room and the turbine room. The new boiler room, Fig. 3, is at the east end of the building and is closed off from the original boiler room by a steel partition wall. The original boiler room contained 6 stoker-fired boilers generating steam at 250 lb. pressure for the first three turbine units. These 250-lb. boilers are now operated to furnish about 60,000 lb. of steam an hour to Olds Motor Works about 1000 yd. from Moores Park and the boilers not

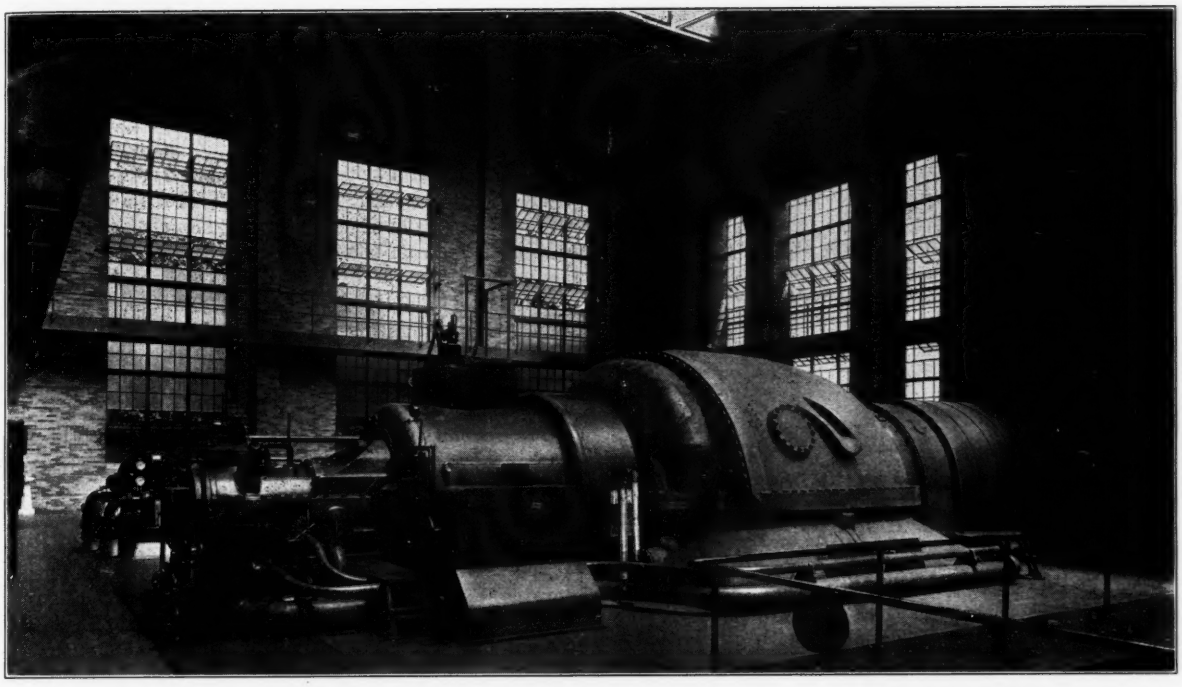


FIG. 2. UNIT NO. 4, WITH A CAPACITY OF 20,000 KW., COMPLETES THE STATION. BOILER FEED PUMPS, SET ON THE TURBINE OPERATING FLOOR, ARE VISIBLE IN THE BACKGROUND AT THE LEFT

used for this purpose constitute reserve boiler capacity.

In the new section of the plant, advantage was taken of the recent developments in generation of high pressure and high temperature steam, and this section was designed for operation at 450 lb. pressure and 700 deg. steam temperature. The four new boilers in this section supply steam for the last three units of the installed turbine-generator units, thus affording the whole plant the advantages and economies of the new steam generating equipment.

One of the principal features of interest at Moores Park is the boiler control room, in which all four boilers can be operated by one man. This room will be described in detail later in this article.

The electrical section is on the west side of the station parallel to the turbine room. This section contains the electrical control room overlooking the turbine room. Below this control room are the compartments containing the 13,200-v. oil circuit breakers, disconnects, buses and accessories for handling the outgoing lines, also the 4000-v. transformers, switches, buses and accessories for controlling the auxiliary circuits. The control room itself contains benchboards for control of generators and main circuits and truck type switchboards for the 4000-v. auxiliary and house circuits. As an additional auxiliary source of power for the station, a 1000-kw. hydroelectric plant a short distance up river from the Moores Park Station is tied in to the 4000-v. bus.

At Moores Park Station, unit No. 4, of 20,000-kw. capacity, is shown in the foreground of Fig. 2. This unit is designed for 425 lb. steam pressure at the throttle, 700 deg. total steam temperature. Four extraction nozzles are provided for feedwater heating and evaporation of makeup water, as will be explained in detail. This turbine exhausts to a 21,500-sq. ft., 2-pass surface condenser, supported on springs below the turbine. Two centrifugal pumps, each of 11,500 g.p.m. capacity at 20.4 ft. head, supply circulating water to this condenser from the circulating water tunnels that lead into the plant from the Grand River Dam.

The above turbine drives a 20,000-kw., 0.8-p.f., 13,200-v., 3-phase, 60-cycle generator at 1800 r.p.m. Power is sent out of the station at this voltage to the transmission lines and substations of the distribution system, and also at 4000 v. through local substation. No step-up transformers are required.

All turbine auxiliaries, such as circulating and condensate pumps, heater drain pumps and boiler feed pumps are driven by 440-v. 3-phase alternating-current motors. The two main boiler feed pumps for the new unit, two of 300-g.p.m. and one of 450-g.p.m. capacity, are set on the turbine operating floor as shown in the foreground of Fig. 6, where they can be supervised by the turbine operators. Stoker drives, coal handling equipment drives are handled by 440-v., 3-phase alternating current. Forced and induced draft fan drives are direct-current motors to give low speeds and flexibility of control.

The direct-current motors take current from a 250-v. d.c. bus, which is fed by two 750-kw., 4000/250 v. motor-generator sets, No. 4 and 5, located on the mezzanine floor at the east end of the boiler house.

Conditioned air is supplied to this room by an air conditioning equipment that filters, washes, humidifies and cools the air so that the motor-generator sets always run in the proper temperature to minimize commutator troubles, to prevent overheating and to insure continuous service for supply of direct-current to essential boiler house auxiliaries.

As shown on the station wiring diagram, Fig. 5,

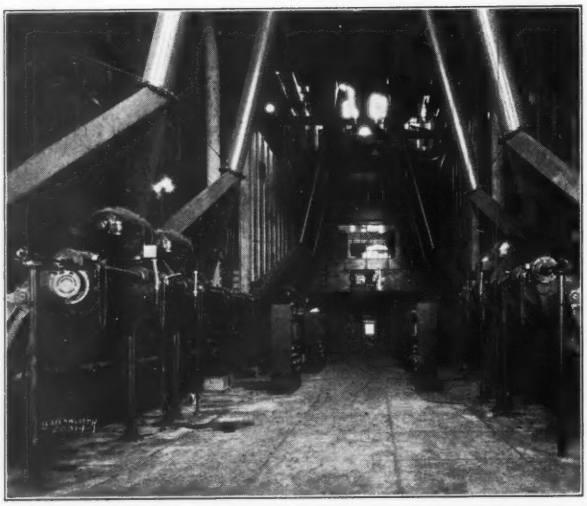


FIG. 3. THE BOILER ROOM ADDITION, CONTAINING FOUR STOKER-FIRED 450-LB. STEAM GENERATING UNITS. CONTROL ROOM WINDOW OVERLOOKS FIRING AISLE

the 750-kw. motor-generator sets are connected to a 4000-v. a.c. bus, which is supplied with current from the main 13,200-v. bus through step-down transformers. To this 4000-v. bus is also connected a 1500-kw. auxiliary turbine-generator, which supplies current in case of failure of the normal supply to the bus. As a further measure to safeguard the continuity of operation, the above-mentioned new 250-v. d.c. bus is connected by a tie feeder to the d.c. bus in the original boiler house. This bus is fed from motor generator sets No. 1, 2 and 3 which take alternating current from a double 440-v., 3-phase, auxiliary bus. Current to this bus is supplied through step-down transformers from the main 13,200-v. station bus. This double 440-v. auxiliary bus is connected by tie feeders to two auxiliary 440-v. a.c. buses, one located in the new boiler room and one in the present boiler extension.

Extraction Heaters

Figure 4 shows the flow of condensate from the condenser through the various heaters to the economizers and boilers. Motor-driven 500-g.p.m. centrifugal condensate pumps send the water from the hotwell first through the condensate bank of the generator air cooler, then to the inter and after coolers of the steam jet air pump on the condenser. Thence the condensate flows to the low pressure extraction heater, where it is heated to about 150 deg. (at full load on the turbine) by steam at 4.15 lb. abs., 154 deg. from the first extraction nozzle of the turbine. The drain pump of the low-pressure heater sends the condensate to the deaerating open heater, to which steam at about 18.9 lb. abs., 222 deg. is supplied from the second extraction nozzle of the turbine. Boiler feed pumps take suction from the deaerating heater and send the feedwater through the high-pressure heater, where it is heated to 250 to 290 deg. It then passes to the steel-tube economizers and enters the boilers at 290 to 380 deg. Raw makeup water is distilled in a 6225 lb.-per-hr. evaporator supplied with 46 or 189 lb. abs. steam from the third or fourth extraction nozzle, Vapor from the evaporator in service goes to the deaerating heater; the evaporator drain water is mixed with the condensate in the heater.

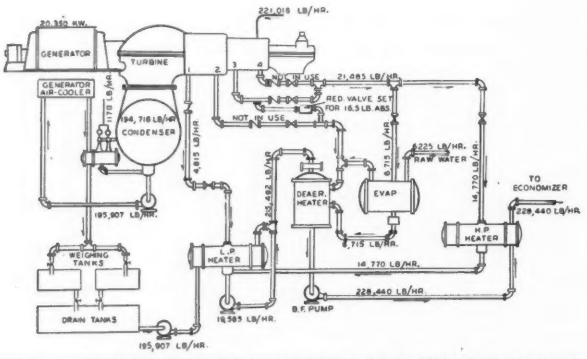


FIG. 4. FEEDWATER FLOW CYCLE AND HEAT BALANCE TAKEN ON TEST OF UNIT NO. 4. CONNECTIONS MARKED "NOT IN USE" WERE ARRANGED THUS DURING THE TEST ONLY; IN REGULAR OPERATION THEY WILL BE USED

Boiler Room

The boiler room addition at Moores Park incorporates the most modern practice in stoker firing, steam generation and automatic control of the plant. Advantage was taken in the new boiler room of the developments made since the plant was begun. The steam pressure was raised to 450 lb., 700 deg. total temperature, water-cooled furnace walls were employed with the stokers, economizers and air preheat-

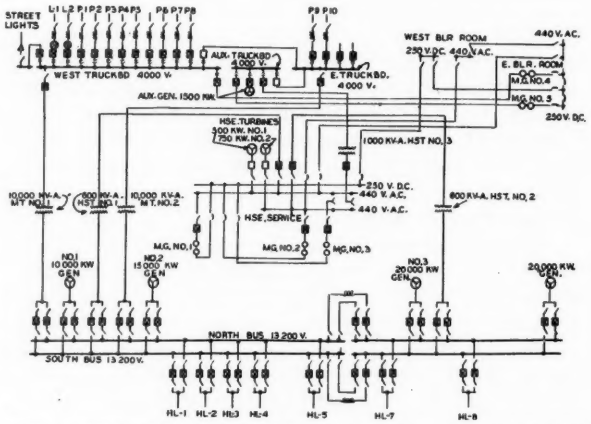


FIG. 5. SINGLE-LINE ELECTRICAL DIAGRAM OF MOORES PARK STATION

ers were employed in the heat balance and modern methods of boiler control were adopted.

Four new boilers have a total steam capacity at maximum rating of 958,000 lb. an hour of 450-lb., 700-deg. steam. Two boilers have 15,950 sq. ft. of heating surface each and two have 18,760 sq. ft. each. They are of the four-drum bent-tube type, each with two 48-in. and two 42-in. drums designed for 570 lb. per sq. in. drum pressure. The mud drums are forge and hammer welded type, the others are riveted.

These boilers are fired by underfeed stokers, two 13-retort and two 15-retort units, all 41 tuyeres deep, with projected grate areas of 382 and 440.6 sq. ft. respectively. These are designed to burn about 55 lb. of coal per sq. ft. per hour at maximum operation, giving a heat release in the furnace of about 29,000

Principal New Equipment Moores Park Station, 1930 Extension

General

Location—Lansing, Michigan
Built by—Board of Water & Electric Light Commissioners
Service—General municipal, industrial and domestic
General Manager, Board of Water & Electric Light Commissioners—Otto E. Eckert
Consulting Engineer—J. E. Woodwell
Resident Engineer—J. H. Speer
Chief Operating Engineer—G. A. Bradley
Total Generating capacity, including new unit—65,000 kw.
Condenser Circulating Water — Grand River
General Building Contractor — H. G. Christman—Lansing Co.
General Electrical Contractor—Hatzel & Buehler, Inc.

Turbine-Generator and Auxiliaries

1 Allis-Chalmers Mfg. Co. turbine-generator, 20,000 kw., 0.8 p.f., 13,200 v., 1800 r.p.m. Turbine is provided with four points of extraction for feedwater heating and evaporator; steam at throttle 425 lb., 700 deg., exhaust 1 in. Hg. Direct-connected 100-kw., 250-v. exciter.
1 Griscom-Russell Co. generator air cooler, capacity 60,000 c.f.m. of air at 14.7 lb., 100 deg. F. or 253,440 lb. an hr. Condensate bank, 2 sections, 12,060 sq. ft. total surface; raw water bank, 2 sections, 9,640 sq. ft. total surface. Six water passes.
1 C. H. Wheeler Mfg. Co. surface condenser, 21,500 sq. ft., 2-pass; inside diameter of shell 10 ft. 6 in., tube sheets 1.375 in. thick, 4480 Muntz metal No. 16 Gage tubes, 0.875 in. O.S. diam., 21 ft. in length between sheets. Two steam jet air pumps, capacity each, 42 c.f.m. at 2 in. back pressure, with inter and after coolers.
2 C. H. Wheeler Mfg. Co. condensate pumps, each 500 g.p.m., 150 ft. head, 1140 r.p.m. driven by Allis-Chalmers 40-hp. motors.
2 C. H. Wheeler Mfg. Co. condenser circulating water pumps, each 11,500 g.p.m., 20.4 ft. head, 350 r.p.m., driven by Allis-Chalmers 75-hp. slip ring motors.

Boilers, Stokers and Auxiliaries

4 Foster Wheeler Corp. Connelly boilers, four-drum bent-tube type. Two units 15,950 sq. ft. heating surface each, two units 18,760 sq. ft. each, maximum steam capacity each 224,000 and 259,000 lb. an hour respectively. Each boiler has two 48-in. drums; mud drums M. W. Kellogg Co. forge and hammer welded steel, others quadruple riveted. Boilers designed for 570 lb. per sq. in. drum pressure. Two boilers 1014 tubes 3-in., No. 7, 39 tubes wide and 20 deep; two boilers, 1196 tubes, 3-in., No. 7, 46 tubes wide and 20 deep.
4 Superheater Co. convection superheaters, two 3400 sq. ft. each, 74 elements 1.625-in. tubes; two 3900 sq. ft. each, 88 elements, 1.625-in. tubes. To give total steam temperature of 700 deg. F.
28 Diamond Power Specialty Corp. soot blowers; 7 units per boiler, 4 calorized and 3 steel units.
4 Foster Wheeler Corp. furnace water walls, rear wall area, two boilers, 296 sq. ft. each, two 330 sq. ft. each. Side walls, four boilers, 258 sq. ft. each side. Tubes 3¼-in., No. 4; recirculators, down comers and up comers, 4 in. Walls designed for 600 lb. per sq. in.
4 Bigelow-Liptak Corp. suspended furnace walls and arches for 4 furnaces. Side walls, total per boiler, 1050 sq. ft.; front walls, per boiler, two 557 and two 637 sq. ft.; front arch, per boiler, two 129 sq. ft., two 147 sq. ft.; ash pit lining, per boiler, sq. ft., two 212, two 245.
4 Foster Wheeler Corp. economizers, steel-tube type, two 7200 sq. ft. each, two 8400 sq. ft. each, designed to heat boiler feedwater from 265 to 370 deg. F. at 400 per cent boiler rating.
4 Foster Wheeler Corp. plate type air preheaters, (1 per boiler) two 16,500 sq. ft. each, two 19,320 sq. ft. each. Designed for the following gas and air temperatures at 400 per cent boiler rating air temp. in 110 deg., out 350 deg., gas temp. in 584 deg., out 391 deg. At this rating and temperature designed to handle 82,500 and 96,500 c.f.m. of air respectively for the two sizes of boilers.
4 American Engineering Co., Taylor underfeed stokers, two 13-retort, 382 sq. ft. projected grate area; two 15-retort, 440.6 sq. ft. projected grate area; all 41-tuyeres. Stoker width 22 ft. 7 in., 26 ft. ½ in., length from rambox to bridgewall, 16 ft. 11 in. Each stoker driven by duplicate and interchangeable 10-hp. d.c. motors through change gear mechanical drives. Each unit has 14-in. double clinker crushers, with hydraulic drives.

Fans and Draft Equipment

4 B. F. Sturtevant Co. forced draft fans with backward curved blades and double width with double inlet boxes. Two units 82,500 c.f.m. each at 110 deg. F., 10 in. H_2O, 1260 r.p.m. driven by 250-hp., 250-v. Crocker-Wheeler d.c. motors operating at 202 hp. Two units 96,500 c.f.m. each of the same description at 110 deg. F., 10 in. H_2O, 1370 r.p.m. driven by Crocker-Wheeler 250-hp., 250-v., d.c. motors operating at 235-hp.
4 B. F. Sturtevant Co. induced draft fans of the double-inlet, double-width multiblade type, with inlet boxes. Two units 133,000 c.f.m. of gas each at 386 deg. F., 12 in. H_2O, 810 r.p.m., driven by Crocker-Wheeler 500-hp., 250-v., d. c. motors operating at 396-hp. Two units, 156,000 c.f.m. of gas each, at 386 deg. F., 12 in. H_2O, 860 r.p.m., driven by Crocker-Wheeler 500-hp., 250-v., d.c. motors operating at 488-hp.
2 Alphons Custodis Chimney Co. radial brick chimneys, 1 for each 2 boilers. Inside diameter at top, 13 ft., 10 in.; outside diameter at bottom, 19 ft., 1 in. Height above roof 177 ft. 9 in.
Breechings and Duct Work.....Connery & Co., Inc.
Duct Insulation.Murphy Asbestos Co.
Damper Drives....Cutler-Hammer, Inc.

Coal and Ash Handling Equipment

1 Weller Mfg. Co. bucket elevator, 75 t. per hr. driven by General Electric Co., 25-hp. motor.
1 Webster Mfg. Co. coal crusher, single roll type, 75 t. per hr., driven by General Electric Co. 30-hp. motor.
1 Weller Mfg. Co. magnetic separator.
1 Weller Mfg. Co. belt conveyor, over coal bunkers, capacity 75 t. per hr. belt 38 in. wide, 100 ft. long, with tripper, driven by 5-hp. General Electric Co. motor.
1 Coal bunker of steel lined with gunnite, total capacity 1000 t.
8 Richardson Scale Co. automatic coal scales, 2 per boiler, capacity each, 300 lb. per discharge.
4 Rolland Gardner Co. Non-Seg coal hoppers.
4 Beaumont Mfg. Co. ash hoppers, two 900 cu. ft. each, two 1025 cu. ft. each. Capacity 27 t. an hr. at 300 per cent boiler rating. Hoppers equipped with Beaumont hydraulically-operated ash gates. Two boilers, 8 gates each 3 ft. 6 in. by 4 ft.; two boilers, 10 gates 3 ft. 6 in. square.

Evaporators, Heaters and Pumps

2 Foster Wheeler Corp. evaporators, single-effect, submerged-coil type, capacity each 4000 lb. vapor an hour taking steam at 46 lb. abs. from the 3rd or 4th turbine extraction nozzle.
2 Cochrane Corp. open, deaerating feedwater heaters, capacity each 228,000 lb. an hr.
2 Foster Wheeler Corp. high-pressure extraction feedwater heaters, capacity each 202,000 lb. water an hour from 224 to 269 deg. F., with steam at 46.2 lb. abs. from No. 3 or No. 4 turbine extraction nozzle.
2 Foster Wheeler Corp. low-pressure extraction heaters, capacity each 165,000 lb. water an hour from 90 to 104 deg. F. with steam at 3.8 lb. abs. from the turbine extraction nozzle No. 1 (the lowest extraction point).
2 Allis-Chalmers Mfg. Co. heater drain pumps, 30 g.p.m. each, 180 ft. head, 3500 r.p.m. motor drive.
3 Allis-Chalmers Mfg. Co. centrifugal boiler feed pumps, two 300 g.p.m. 5-stage, 3550-r.p.m. and one 450-g.p.m. 7-stage 1760-r.p.m. motor driven pumps all designed for 1485 foot head.
1 Service pump, 1—1000 g.p.m. 100 ft. head, 1750 r.p.m.
1 Allis-Chalmers Mfg. Co. Surge pump, motor driven, 400 g.p.m. 150 ft. head, 1740 r.p.m.
1 Allis-Chalmers Mfg. Co. air cooler pump for generator No. 4, 375 g.p.m. 40 ft. head, 1720 r.p.m.

Miscellaneous Mechanical Equipment

Boiler Settings.....National Power Const. Co.
Water Columns.....Reliance Gauge Column Co.
Hoists and Trolleys.....Hanson Equipment Co.
Air Conditioning Equipment for motor-generator sets....Niagara Blower Co.
Lubricating oil purifiers.....S. F. Bowser & Co.
Lubricating oil filters.....S. F. Bowser & Co.
Vacuum Tripper.....Consolidated Engine Stop Co.
Combustion control system.....Smoot Engineering Co.
Feedwater Regulators.....Stets Co.
Piping.....National Valve & Mfg. Co.
Pipe Insulation...Fred Sprinkman Co.
Valves....Chapman Valve & Mfg. Co.
Boiler Safety valves.....Consolidated Ashcroft Hancock Co.
Boiler-Non-return valves.....Edward Valve & Mfg. Co.
Boiler Blowoff valves.....Yarnall-Waring Co.
Blowoff valves.....Strong, Carlisle & Hammond Co.
Gate valves, motor-operated.....Chapman Valve & Mfg. Co.
Extraction heater valves.....Atwood & Morrill Co.
Steam Traps.....Strong ,Carlisle & Hammond Co.
Insulation on condenser and water piping.....Master Mechanics Co.

Meters and Instruments

Recording gages and thermometers.....Brown Instrument Co
Steam Flow meters..Bailey Meter Co.
Draft Gages...Ellison Draft Gage Co.
CO_2 recorders.....Bacharach Industrial Inst. Co.
Indicating gages for pressure, temperature, speed, etc.
....Bristol Co., G. E., Brown Inst. Co.
Master Load Indicators.....General Electric Co.
Temperature recording instruments..Leeds & Northrup Co.
Motor Controls for fans and stokers..
..General Electric and Smoot Eng. Co.
Turbine control boards.....General Electric Co.
Boiler control boards.....General Electric Co.
Turbine signal system.....General Electric Co.
Clocks.....General Electric Co.

Electrical Equipment

Distribution switchboards.....General Electric Co.
Station auxiliary board, Truck type...General Electric Co.
Main 13.2-kv. oil circuit breakers.....General Electric Co.
Disconnecting switches.....General Electric Co.
Deceleco switch compartments.....Deceleco, Inc.
General Electric Co. House service transformers, capacity 600 and 1000 kv-a., 13,200/400 v.
2 G. E. Co. motor-generator sets, capacity each 750 kv-a., motor syncr. 1100 kv-a. 4000 v., generator 750 kw., 250 v.
Air Circuit Breakers.....General Electric Co.
Motors, 250 v. d.c. fan drives.....Crocker-Wheeler Mfg. Co.
Stoker Motors and controls.....General Electric Co.
Pump motors.....Allis-Chalmers Mfg. Co.
Lighting Cabinets.....General Electric Co.

Building Contractors

General Excavation.....Lansing Excavating Co.
Foundations.....Spencer, White & Prentis
Structural Steel...Whitehead & Kales
Reenforcing Steel..Capitol Steel Corp.
Gunnite.....Cement Gun Co.
Rolling Steel Doors.Kinnear Mfg. Co.
Miscellaneous iron and steel, gratings, ladders, etc.....Jarvis Engineering Works

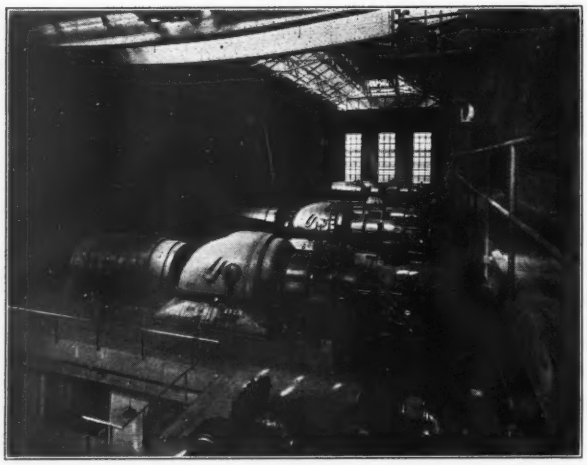


FIG. 6. GENERAL VIEW OF COMPLETED TURBINE ROOM, WITH UNIT NO. 4 IN FOREGROUND

B.t.u. per cu. ft. per hr. They are driven by two 10-hp. motors each, through three gear boxes designed to give flexible and selective speed control over the entire range.

Clinker crushers are provided on each stoker and the ash from these drops into ash hoppers that have a capacity of 27 t. an hour each at 300 per cent boiler rating. From these hoppers the ash discharges through oil-operated ash gates directly into trucks for disposal outside the plant. An interesting feature of these ash gates is the layout of oil piping for operating the gates. This is led to manifolds on the side walls of the ash basement, making an extremely neat appearance and providing also a convenient and safe method of operation.

Coal is crushed, elevated to a 1000-t. steel, concrete lined bunker over the boiler room firing aisle and spouted to the stokers through non-segregating hoppers. Coal is weighed by continuous weighing and automatic registering scales, 2 per boiler. Coal usually burned at Moores Park is Logan Co., W. Va. bituminous coal, having the following typical analysis: heating value (dry) 14,136 B.t.u.; carbon 77.92 per cent; hydrogen 5.33 per cent; oxygen 5.46 per cent; nitrogen 1.30 per cent; sulphur 0.76 per cent; ash 9.23 per cent. It is stored in stock pile, holding from 15 to 30,000 t., and is reclaimed by locomotive crane and grab-bucket, delivered to track-hopper, then with a belt feeder to the crusher and from there, by means of a vertical bucket elevator to a magnetic separator and horizontal conveyor which distributes it to overhead storage bunkers.

Control of the four new boilers is centralized in a new boiler control room, between the new boilers and the new turbine No. 4, overlooking the firing aisle on one side as shown in Fig. 6, and the turbine room on the other through a bay window shown at the right in Fig. 7. Each boiler is equipped with its individual boiler panel, set on the firing floor in front of each stoker as shown in Fig. 3. These individual panels carry indicating gages for the combustion control system, pressure and draft gages and the necessary controls by which each boiler can be operated individually if desired. Under normal operating conditions, however, the boilers will be completely controlled from the boiler operating room.

This room contains three panels. The center panel, shown in the background of Fig. 7, is the master panel of the combustion control system and carries all the necessary gages, recording instruments and master regulators for the system, which governs fan and stoker speeds and dampers to maintain steam pressure, boiler output and proper combustion conditions. The panel shown at the left of Fig. 7 is duplicated on the other side of the room. These two panels are arranged so that the operator standing in front of them has at his command all the master controls for fans, stokers and auxiliaries and all the indicating and recording meters and signals for operating the four boilers.

The station building itself is of red brick and steel construction, with stone and terra cotta trim, as shown in Fig. 1. One of the interesting features of the building steel work is the method of bracing employed. Practically no vertical, diagonal or wind bracing is used but instead of this each beam connection is braced with short sections of steel shapes cut from heavy steel I-beam sections producing a cantilever result. This results in a neat appearance, a large saving in steelwork and is stated to be entirely satisfactory as to rigidity and stiffness.

The interior of the building is attractively finished in buff brick, with many windows to provide natural illumination and with good artificial lighting. Plenty of space is left around equipment so that it is easy of access and the entire station presents an appearance of spaciousness and order and shows the care that has been given to each of its details.

The entire station was designed by J. E. Woodwell, consulting engineer, of New York, who carried out the design from the beginning according to a definite program of keeping pace with the development of Lansing and the developments of the power plant industry. It was built by the Board of Water & Electric Light Commissioners of the City of Lansing, with Otto E. Eckert, general manager and Hugo Lundberg, chairman. J. H. Speer was resident engineer for Mr. Woodwell and G. A. Bradley is chief engineer of the station. To all of these men we are indebted for the most cordial coöperation in visiting the station and obtaining the data used in this article.

FIG. 7. VIEW IN BOILER CONTROL ROOM; COMBUSTION CONTROL MASTER PANEL AT RIGHT, BOILER PANEL FOR TWO BOILERS AT LEFT

Steam Generation Unit

DESIGN IN WHICH FURNACE, CONVECTION SURFACE, SUPERHEATER AND AIR HEATING ARE RELATED FOR BEST ECONOMY, INSTALLED AT SOLVAY PROCESS CO.'S PLANT. BY HENRY KREISINGER*

AT PRESENT, makers of equipment show a strong tendency to combine and organize so that they can design and build a complete steam generating unit in convenient sizes, similar to the development that has been going on for many years among the manufacturers of steam turbine equipment. Such complete units greatly simplify the design of power plants, also reduce the labor and shorten the time of preparing propositions by the manufacturers of the equipment.

One such design is shown in Figs. 1, 2 and 3. Figure 1 shows the external appearance of the unit, which has a completely water-cooled furnace but no external connections between the furnace and the boiler. Figure 2 is a vertical section through the unit showing the arrangement of the various parts. Figure 3 is a horizontal section through the unit at the burner level.

As shown, the unit, which has unrestricted access to all parts for inspection and maintenance, is adaptable for burning pulverized coal, blast furnace gas, natural gas or fuel oil. The furnace is nearly square in cross section, with height approximately twice the width. It is completely surrounded by the boiler so that no refractory is needed, except narrow bands in the corners and the low walls around the ash hopper.

WATER ENCLOSED FURNACE

Protection of the ash hopper from heat is by a water screen consisting of two rows of nearly straight tubes supplying water to the part of the boiler forming the front wall of the furnace and two rows of bent tubes supplying water to the part of the boiler forming the side walls of the furnace. The rear wall of the furnace is formed by two rows of tubes extending from the lower to the upper drum and supporting a gas-tight tile partition. The roof of the furnace is four rows of nearly horizontal tubes which serve as risers for taking the water and steam from the tubes forming the front wall of the furnace. Thus, a completely water-cooled furnace is obtained with no external riser or downcomer, tubes which serve this purpose being also active heat absorbers.

SUPERHEATER CHAMBER

Above the tubes forming the roof of the furnace is a chamber containing the superheater which is suspended from a steel frame above the top and outside of the unit, so that none of its weight rests on any of the active water-heating surfaces. Elements of the superheater are replaceable through the light brick partition forming the front wall of the superheater chamber. The side walls of this chamber are the continuation of the water-cooled furnace side walls. The roof is formed by two rows of bent tubes which deliver water and steam from the side walls of the furnace to the steam drum, are exposed to the hot gases flowing through the superheater chamber and are, therefore, active heat-absorbing surfaces.

*Consulting Engineer, Combustion Engineering Corp.

Water supplied from the lower drum to the parts of the boiler forming the furnace walls makes a complete circuit only once and is returned with the steam made to the upper drum, so that no undue concentration of water impurities occurs in the active parts of the boiler which form the furnace walls and absorb heat at high rates. This lessens the chance of impurities baking on the inner surfaces of furnace walls which are subjected to intense heat, where high concentration is likely to cause damage.

GAS CIRCULATION

In the furnace, designed for the tangential method of firing, one or more burners are placed in each corner near the bottom, jets of a mixture of air and fuel being blown in horizontally, tangent to a circle in the center of the furnace. Products of combustion flow upward through the combustion space, passing through the furnace roof bank of tubes into the superheater chamber.

After leaving the superheater, hot gases enter the convection bank of vertical tubes, which are rolled into the two drums, and flow downward to the lower end, then make an upward turn into the air heater. Gases, therefore, make only three passes through the entire unit. The first upward through the furnace, the second downward through the convection bank of tubes and the third upward through the air heater.

Important in the design of the unit is a superheater bypass for the hot gases. In case the temperature of the steam becomes too high, the dampers in

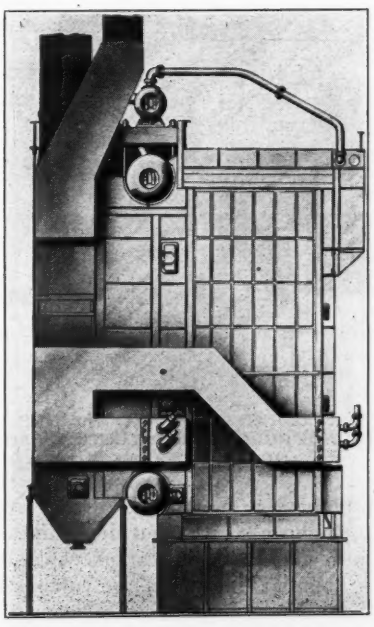


FIG. 1. SIDE VIEW OF UNIT SHOWS FREEDOM FROM EXTERIOR CONNECTIONS

this bypass are opened so that part of the hot gas short-circuits the superheater and flows directly into the convection bank. Dampers in this bypass are made of special cast iron and stand well the temperature to which they are subjected. By their use, an adjustment up to 100 deg. F. in the temperature of steam is possible.

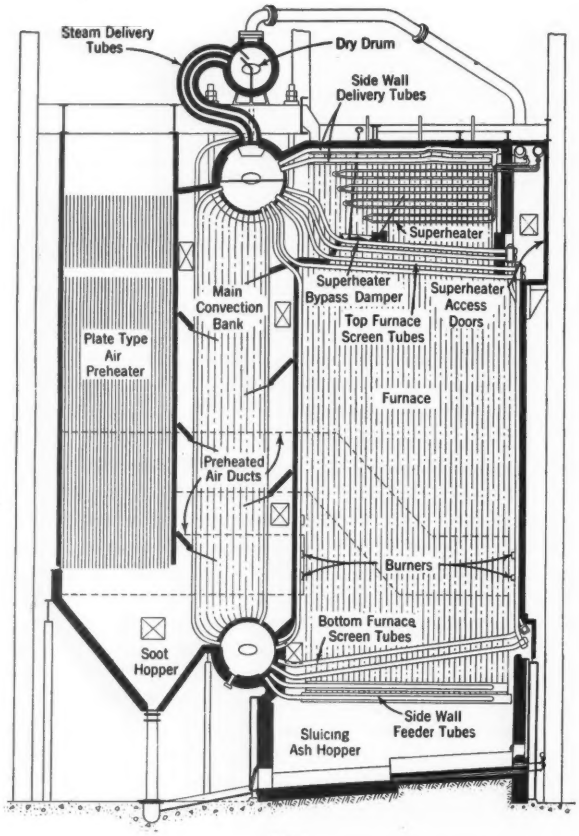


FIG. 2. VERTICAL SECTION OF COMPACTLY ARRANGED UNIT

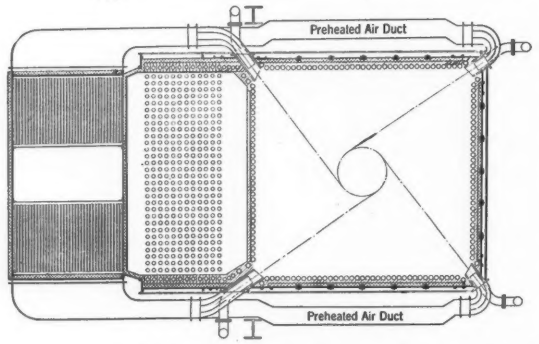


FIG. 3. HORIZONTAL SECTION AT BURNER LEVEL THROUGH FURNACE, CONVECTION BANK AND AIR PREHEATER

By the tangential method of firing is produced intensive turbulence of the burning mixture and a rotative motion so that the mixture completely fills the furnace, thus making all of the combustion space effective. This makes it possible to operate the furnace at high average rates of heat liberation with small loss from incomplete combustion. Complete enclosure of the furnace with bare water-cooled surface reduces the slagging of the furnace roof tubes even at high rates of heat liberation, so that no special spacing is required. Heat liberation rate of 30,000 B.t.u. is quite practicable with the average grade of steaming coals.

Output limit is entirely dependent on the volume of fuel which can be fed to the furnace, uninterruptedly. With direct firing of pulverized fuel, this output is determined by the capacity of the mills. With the storage system, it depends on the range of the pulverized-coal feeder speeds.

Number of burners used in each corner depends on the size of the unit. On small units, direct fired with one mill, there may be only one burner in each corner; on large units there may be 3 or even 4 burners in each corner, depending on the number of mills supplying pulverized coal and the feasibility of dividing the coal stream from each mill. Possible output depends, obviously, on the number of burners used.

Heat Absorption

Three kinds of heating surfaces are provided, namely for water heating, steam heating, and air heating. Heat absorption by the various parts of the unit is shown graphically in Fig. 4, the horizontal values of the chart giving the heating surface of the different parts of the unit in square feet and also in percentage of the total heating surface of the unit. Thus the furnace has 2832 sq. ft. which is about 6 per cent of the 43,040 sq. ft. total heating surface.

Three vertical scales are, the temperature of the products of combustion as they pass over the several kinds of heating surfaces, the heat absorbed expressed in 1,000,000 B.t.u. per hour and the heat absorbed expressed in percentage of heat in the fuel burned. The curves are from carefully-measured temperatures and other data collected during a test of a unit which has now been in operation several months. It was designed for 150,000 lb. per hour actual evaporation at 800 lb. absolute pressure and a total temperature of 750 deg. F.

At the burner level, the temperature of the flame is 2400 to 2600 deg. F. Heat liberated by combustion is quickly diffused in the burning mixture and a large part of it absorbed, mostly by radiation, by the heating surfaces around the furnace. At the top of the furnace, just before the products of combustion pass among the furnace roof tubes, the temperature is about 1900 deg. F. and is fairly uniform across the entire section to within about 4 in. of the walls, as determined by measurements with a platinum thermocouple.

Furnace roof tubes reduce the temperature of the gases to about 1600 deg. F. at which temperature they enter the superheater. The superheater, the main convection bank of water tubes and the air heater lower the temperature of the gases successively to 1050, 700 and 390 deg. F. Reduction of the temperature by a given surface is less as the temperature becomes lower, due largely to the smaller temperature difference between the gases and the heat absorbing surface. For this reason a large air heater is used, built for low pressures, hence much less expensive than high-pressure water-heating surface. It has the additional advantage over water-evaporating surface that, by the use of the counter-flow principle, a greater temperature difference between the gases and the air can be obtained.

The heat absorption curve is symmetrical to the temperature curve, the slope of each section being proportional to the average rate of heat transfer. The most noteworthy point is the large amount of heat absorbed by the furnace, about 53 per cent of the total heat in the fuel burned and about 62 per cent of the heat absorbed by the unit. The whole unit absorbs 86 per cent of the heat in the fuel, of which 72.5 per cent is used in evaporating water and 13.5 per cent in superheating the steam. Of the 72.5 per cent heat used in evaporating the water, 53 per cent is absorbed by the furnace and 19.5 per cent by the convection surface, so that the furnace, with a little over 19 per cent of the total water-evaporating surface, evaporates about 73 per cent of the total water evaporated by the unit; convection surfaces, some 81 per cent of the total water-evaporating

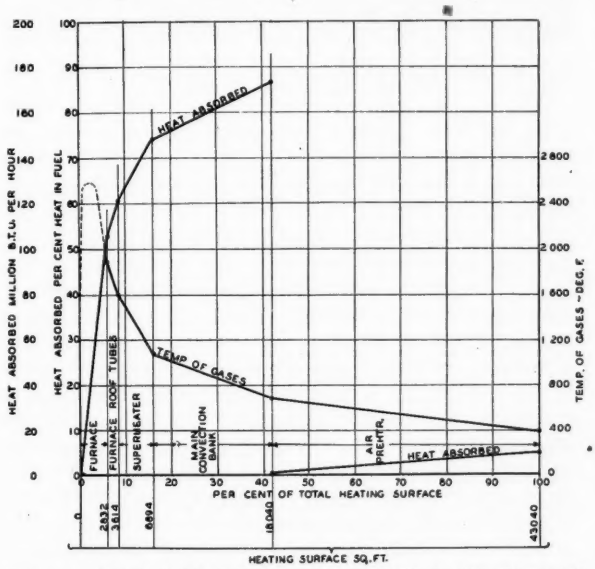


FIG. 4. HEAT ABSORPTION AND HEATING SURFACE IN VARIOUS SECTIONS OF THE UNIT

surface, make only 27 per cent of the total steam. These figures show the desirability of taking full advantage of furnace wall effectiveness.

Although the curve of heat absorption stops with the main convection bank of tubes, it includes the heat given by the air heater to the air used for combustion. Only the heat of the fuel is charged to the furnace but the heat really supplied to the furnace is the sum of the heat in the coal plus the heat returned in the preheated air, which latter must be absorbed by water or steam heating surface before it can be carried away by the steam and utilized. The furnace surfaces absorb most of the heat returned by the air heater.

Absorption by heating surfaces of the furnace is at the rate of 37,500 B.t.u. per sq. ft. per hr., including the heat absorbed by radiation into the four rows of furnace roof tubes. Absorption rate of these tubes by convection is about 19,000 B.t.u. or about one half that for the furnace surfaces exposed to radiation. Higher absorption by the furnace surfaces is due to higher temperature of the furnace gases and to the fact that the heat is transmitted by radiation, which increases faster with higher temperature than heat transfer by convection.

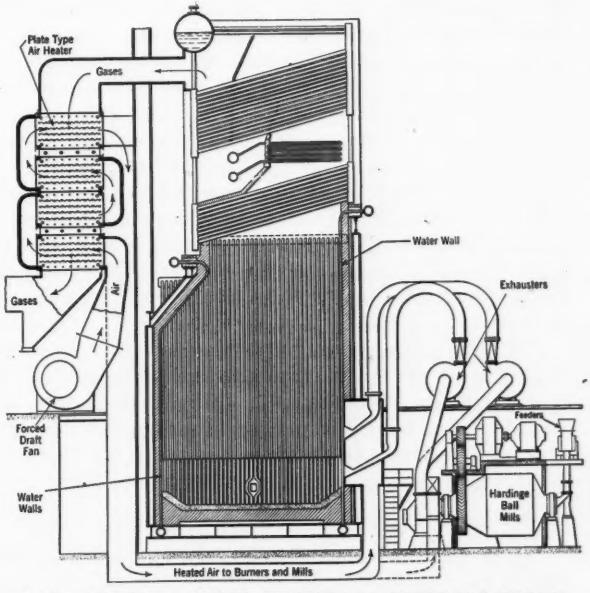
Another advantage of heat transfer by radiation is that it is unaccompanied by a draft loss. If heating surfaces of the furnace were arranged so that the hot gases must pass over them and give up heat by convection, additional draft would have to be provided to make up for friction losses of the gases moving over the surfaces.

It is, therefore, advantageous to design steam generating units so that as much as possible of the heating surface is exposed to radiation. With such arrangement of heating surface, a large furnace becomes to a considerable extent an asset, because it facilitates the exposure of a large amount of the heating surface to radiation.

Placing the entire apparatus within one compact setting greatly reduces the area of the external surface, while with the furnace enclosed within the boiler, external surface is kept at low temperature without the use of thick heat insulating materials, so that radiation loss is minimized.

New Pulverized Coal Unit at Glenlyn Station

INCORPORATING a number of new features, a new steam generating unit fired by two Hardinge ball mills is now nearing completion at the Glenlyn Station of the Appalachian Electric Power Co. The new unit consists of a 2447-hp. Babcock & Wilcox boiler, equipped with a Foster Wheeler water-cooled, slag tap furnace and a 41,160-sq.ft. plate type air heater. Pulverizers are located on the lower floor of the boiler room with exhausters and control on the main operating floor above. Each mill is placed in a soundproof housing and is driven by a separate motor. A cross section of



DIAGRAMMATIC ARRANGEMENT OF THE NEW STEAM GENERATING UNIT AT GLENLYN STATION

the boiler is shown in the accompanying drawing, which is a diagrammatic arrangement as the mills are actually placed at right angles to the position shown and are located at one side of the boiler instead of the front as shown.

Cutting Industrial Power Costs

PURCHASED POWER AND HEATING LOAD DEMANDS CORRELATED TO LIMIT POWER DEMANDS AND REDUCE COSTS. BY F. O. WALLENE*

WITH THE ever increasing need for economy, executives as well as engineers are constantly seeking improved methods of power plant operation. This prompted the development of a system whereby the purchased power source and the private power plant could be so correlated, with safety to both, that the result would be an overall economic gain. Regardless of size, the Sanitary Milk Co.'s plant at Canton, Ohio, referred to in this article, is in effect typical of industrial plants using purchased electric power and requiring steam for process work and heating. This installation has been in operation for over four years.

For the purpose of explanation, consider that purchased electrical energy and the required heat energy be known as primary and secondary sources of power. The cost of primary power is dependent not only on the number of kilowatt-hours used but also on the maximum demand over a given period of time. Usually the demand is based on a 1-hr. interval, although 15 and 30 min. intervals are also common. In many cases, the highest peak demand registered in one month controls the billing for the ensuing year. Obviously, an automatic control to limit the maximum demand is important to the power user and such equipment has long been obtainable.

Abstracting the pressure energy from the boiler steam before it enters the process system by means of expansion through an engine or turbine is an old art and the economic gain derived therefrom has been often demonstrated. Considered individually, the maximum demand control and the pressure energy or exhaust pressure control will each show a gain in economy.

To obtain the maximum saving, however, the two must be correlated so that the available energy in the steam shall accomplish a similar reduction in power drawn from the primary source, and in addition must restrict the all-important maximum demand for primary power within predetermined limits.

PURCHASED POWER HELD WITHIN DEFINITE LIMITS

A special load-control relay shown in the upper corner of Fig. 3 with its cover removed is the crux of the system. This instrument is responsive to the rate of flow of electric power from the primary source and also the demand for heat or secondary energy by the plant. It maintains the power flow from the primary source, between predetermined maximum and minimum values, the maximum point because of power cost, and the minimum that there may be no reverse flow of power into the primary source during such time when the heat energy demand may be high. Between these limits the demand for low-pressure or process steam by the plant controls the rate of flow of energy obtained from the primary source.

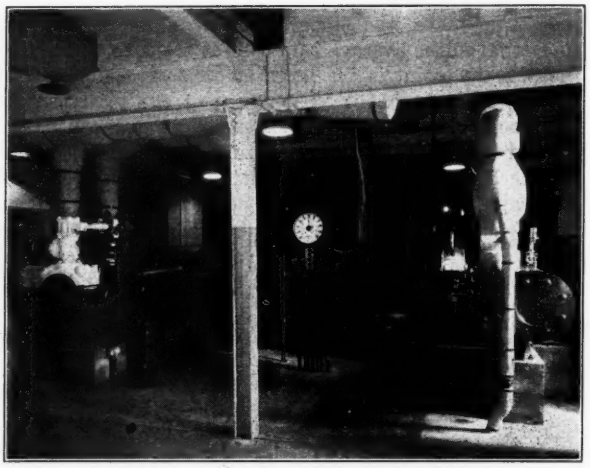


FIG. 1. REFRIGERATION UNIT OF THE SANITARY MILK CO. HAS DUAL DRIVE

In this particular installation, the mechanical arrangement used, shown by Fig. 1, is a side crank engine direct connected, by means of a magnetic clutch, to a side crank ammonia compressor which is also driven by a flywheel type synchronous motor which is in turn operated from the primary power source. The engine is started and stopped without interfering with the operation of the compressor. The load-control relay becomes operative after the clutch is engaged and controls a small motor, shown in Fig. 3, which changes the governor setting on the engine. The engine then assists the primary power source in carrying the compressor load. In this instance the engine capacity is double that of the horsepower required to drive the compressor. As the steam demand increases and the engine does more work, the motor automatically becomes a generator, thereby further assisting, by carrying a portion of the power load taken by the balance of the plant. Obviously, many variations from the exact mechanical layout herein used, are obtainable to suit each particular plant condition.

Original electrical and steam load requirements of this particular plant before any change was made are shown by Fig. 2A. The curves were obtained from actual average readings of electric and steam meters and taken during an average summer day when no plant heating was required and when, obviously, the possible saving is at a minimum.

When the milk begins to come in at 4:30 a.m. the electrical load starts to increase. At 5:30 steam requirements begin. At 8:30 the steam demand has reached its peak. The electrical load does not reach a peak until 11:00 a. m. when the refrigerating equipment has then caught up with the plant demands for refrigeration and also other plant load begins to taper off. The steam demand keeps dropping from 9:00 a. m. until 6:00 p. m. when no further heat is required.

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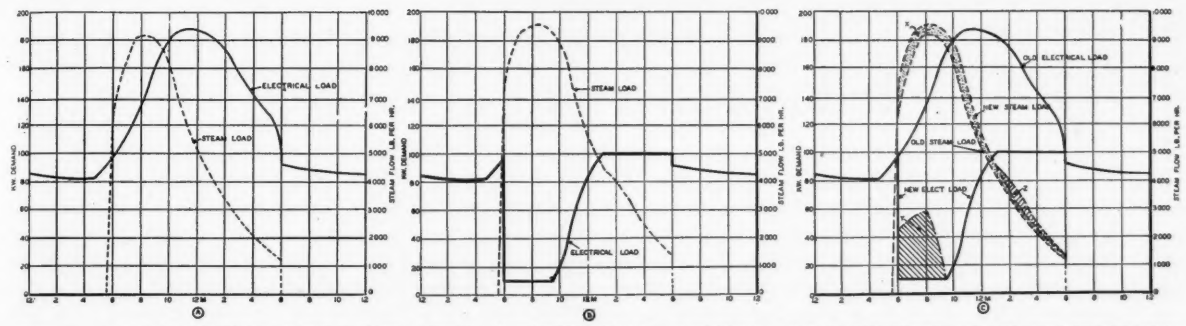


FIG. 2. A. LOAD BEFORE (LEFT) AND AFTER (CENTER) LOAD CONTROL WAS INSTITUTED WITH SUPERIMPOSED CURVES (RIGHT) SHOWING X, ADDITIONAL STEAM LOAD DUE TO POWER GENERATION, Y STEAM SUPPLY THROUGH REDUCING VALVE AND Z STEAM WASTED TO ATMOSPHERE

Figure 2B shows electrical and steam loads after the change had been made. The steam engine is started at 6:00 a. m. shortly after the steam load comes on and before the electrical load has reached the predetermined limit of 100 kw. The demand for exhaust steam is now in excess of what the engine can supply, the deficit being supplied by the boilers through a standard reducing valve. Because of the work done by the engine, the power taken from the primary source drops to the predetermined set minimum of 10 kw. and continues until 9:30 when the steam demand has receded until the engine is now able to supply all the steam required. As the exhaust steam demand recedes further, the engine permits a greater demand on the primary source. The continuous reduction in steam demand would at 1:00 p. m. allow the electrical load to impose an excess demand on the primary source were it not for the fact that the automatic load-control relay causes the engine to hold the load below the set maximum value of 100 kw. At this point the exhaust steam is in excess of that required for process work. The surplus escapes to the atmosphere through the back pressure valve.

Figure 2C shows the increment of heat, marked Z, lost to atmosphere during the period from 1:00 to 6:00 p. m. The gain made from reduced maximum demand charge and kw-hr. generated during the period is many times that of the cost of heat lost during the period. The curves also show the amount of boiler steam, marked Y, bled direct into the process steam between 6:00 a. m. and 9:30 a. m. at the time when the engine exhaust is insufficient to supply the demand. Shaded area, marked X, shows the approximate amount of steam actually consumed by the engine. It represents heat converted into work and radiation loss. Cost records do not indicate nearly as great an increased coal consumption which is partially accounted for by the fact that this added increment of steam is generated more efficiently, as the boiler losses do not increase in proportion with the steam load.

It should be noted on the curves shown that steam is required only during the day. During the heating season when steam is required day and night, the saving is much greater as the engine is run day and night. During the first year's operation, a careful monthly check was kept of power plant costs, and compared with the previous year's operation. Although many plants would offer far more favorable conditions, yet the initial cost of this installation (approximately $8000.00) was saved in less than one year.

This system of control has been installed on a 750-kw. engine generator unit, in a steel mill and on a 2500-kw. turbo-generator unit in an industrial plant. The requisite protection equipment is provided for and includes; overload, reverse-power, and loss-of-primary-power. Means are also provided whereby the engine may be operated to carry the plant load in case of primary power failure.

Obviously, each installation must be studied and properly designed to obtain the most efficient and correct mechanical and thermal layout. It can be safely said, that in general, "For each ton of coal burned for generating process and heating steam, 300 kw-hr. of power may be realized." Available boiler pressure and the required low pressure temperature would have a bearing on this amount.

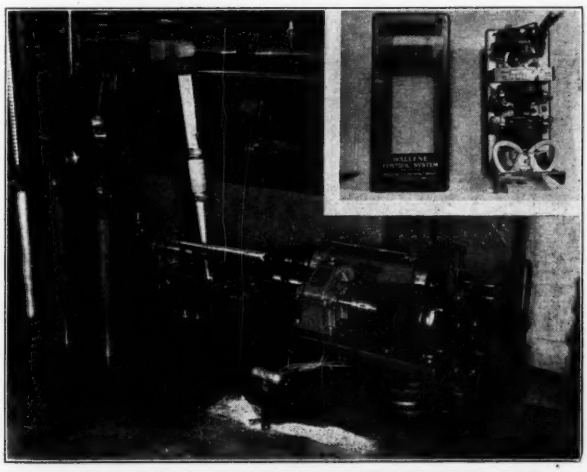


FIG. 3. LOAD CONTROL RELAY (INSERT) AND MOTOR CONTROL ON ENGINE GOVERNOR

FOR THE NEXT 6 mo. General Electric Co. is adopting a plan devised by President Swope virtually to guarantee employment to its shop workers. Employes are to be assigned work, outside their regular work if necessary, at prevailing rates of pay, so as to divide the work available and avoid any layoffs without compensation. All on the payroll as of Nov. 1 will receive not less than one-half their average full-time weekly earnings but not over $15 a week unless actually earned. To make up deficits, employes who are working more than half time contribute two per cent of earnings, the company also increasing its payment to the fund.

1700 lb. Industrial Plant of Novel Design

ILSE-BERGBAU A.G. PLANT BURNS BROWN COAL, USES STOKERS AND PULVERIZED FUEL IN THE SAME FURNACE, HAS THREE-CYLINDER BACK PRESSURE TURBINES WITH STEAM REHEATERS AND USES ALL EXHAUST STEAM IN COAL DRYERS

AT THE RENATE BRIQUETTE FACTORY, the Ilse-Bergbau A.G. erected a new power plant of novel design which because of its economy should be of wide interest to all industries using process steam. The present plant consists of two 1700-lb. boilers each with a normal capacity of 75,000 lb. per hr. of steam and operating at a normal pressure of from 1500 to 1600 lb. per sq. in. to supply steam to two 12,000-kw., triple casing, extraction, back pressure turbines at normal throttle conditions of about 1420 lb. 842 deg. F. At the end of the second turbine cylinder, the steam is reheated at 190 lb. pressure to 545 deg. F. Some of steam is then used for driving briquette presses and feed pumps and the balance is then expanded down from 30 to 50 lb. pressure and then used in coal dryers.

Two of the interesting features of this plant are the remarkably low water rate and flexibility of the machines. Operating against the back pressure of 50 lb. and no bleeding, the water rate at a load of 8500 kw. is 16.6 lb. per kw-hr.; at 6000 kw., the water rate decreases to 15.32 lb. per kw-hr. The high-pressure part can be uncoupled and used alone or it can be used in conjunction with the intermediate-pressure cylinder. In the first case, throttled live steam is sent into the intermediate-pressure casing. In the second case, the low-pressure cylinder works alone with 185 lb. gage, 626 deg. F. steam supplied from low-pressure boilers from another plant.

This briquette factory is in the East Elbe Lignite district where the moisture content of the coal runs from 56 to 58 per cent. Prior to treatment, the coal is delivered to steam heated dryers, from 1.5 to 1.6 lb. of steam being required to produce 1 lb. of briquettes. The steam drying pressure ranging from 28 to 57 lb. per sq. in. gage. Steam demand for briquette work ranges from about 192,000 lb. of steam at normal load to about 215,000 lb. of steam at maximum load. Added to this is the steam load of the steam reheater which amounts to approximately 17,500 lb. of steam per hour full load. The plant, which was designed by the A.E.G., is designed for four boilers (one of which is to serve as a standby), each with a normal output of 75,000, a maximum output of 88,000 lb. of steam per hour.

PRESSURE DROPS

At present two Borsig boilers of slightly different construction are installed. Both are built for a maximum pressure of 1700 lb. per sq. in. but operated at 1630 lb. per sq. in., 890 deg. F., in order to avoid unnecessary popping of the safety valves. With pressure drops of about 43 lb. in the superheater and about 100 lb. in the steam lines, steam conditions of 1500 lb., 840 deg. F., can be obtained at the turbine inlet. Each boiler is equipped with a superheater, economizer and air heater designed to reduce the temperature of the gas at combustion to about 480 deg. F., as low as it is advisable to go with such cheap fuel.

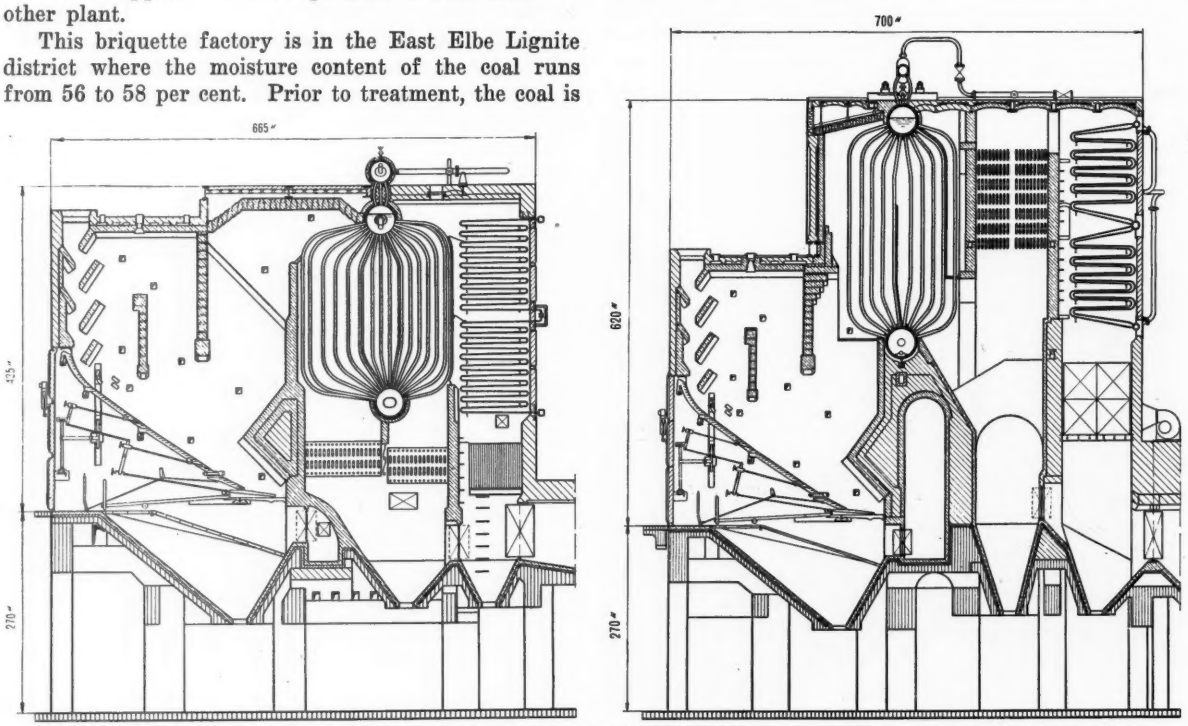


FIG. 1. TWO TYPES OF BOILERS ARE INSTALLED. THE EVAPORATION IS ABOUT 17 LB. PER SQ. FT. OF SURFACE AT MAXIMUM LOAD

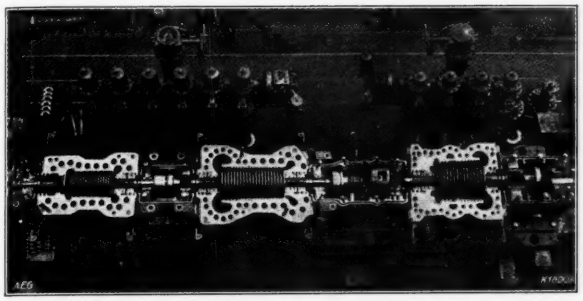
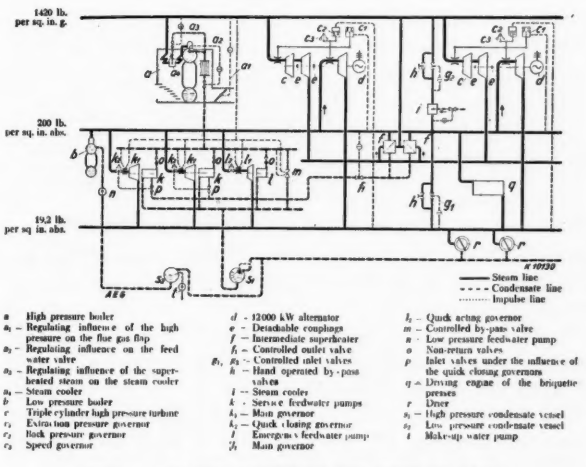


FIG. 2. FRONT VIEW OF THE OPEN TURBINE

The first boiler shown at the left of Fig. 1 has a heating surface of 5520 sq. ft., a 2570-sq. ft. superheater, 7350-sq. ft. economizer and a 7750-sq. ft. air heater. The maximum and normal rate of steaming and evaporation per sq. ft. of boiler surface are 13.5 and 16 lb. per sq. ft. respectively. Feedwater to the economizer at a temperature of about 265 deg. F. is raised to 515 deg. before entering the boiler. The combustion air passing through the air preheater is raised to about 375 deg. F. before entering the furnace.

The second boiler shown at the right of Fig. 1 has a heating surface of 5000 sq. ft., a superheater surface of 6450 sq. ft., an economizer surface of 9130 sq. ft. and an air preheater surface of 8600 sq. ft. The economizer and air preheater are designed for the same temperature as No. 1 boiler. In both units a bypass damper is provided to cut out the economizer and air preheater when the boiler is put into service.

Both units are fired by brown coal or lignite by Keilmann & Volcker stokers. The heating value of this coal is about 3600 B.t.u. per lb., moisture content about 58 and ash content of approximately 4 per cent. As shown by both boiler sections, Fig. 1, the top section of the grate can be tilted upward to cut off the coal supply in emergencies. Tilting of this grate leaves an opening of about 1 ft. 4 in. wide through which cold air can flow directly into the combustion chamber, thus by passing the grate and stopping combustion. In addition to this stoker, auxiliary pulverized coal firing is provided. The pulverized coal being obtained from the electrostatic separator in the briquette works. By means of the reserve in the coal hopper, auxiliary coal firing can carry about 20 per cent of the boiler load for a period of 5 hr. A 426-ft. stack, 16.5 ft. diameter at the top, is provided to serve both boilers.



a – High pressure boiler
a_1 – Regulating influence of the high pressure on the flue gas flap
a_2 – Regulating influence on the feed water valve
a_3 – Regulating influence of the superheated steam on the steam cooler
a_4 – Steam cooler
b – Low pressure boiler
c – Triple cylinder high pressure turbine
c_1 – Extraction pressure governor
c_2 – Back pressure governor
c_3 – Speed governor
d – 12000 kW alternator
e – Detachable couplings
f – Intermediate superheater
f_1 – Controlled outlet valve
f_2, f_3 – Controlled inlet valves
h – Hand operated by-pass valves
i – Steam cooler
k – Service feedwater pumps
k_1 – Main governor
k_2 – Quick closing governor
l – Emergency feedwater pump
l_1 – Main governor
l_2 – Quick acting governor
m – Controlled by-pass valve
n – Low pressure feedwater pump
o – Non-return valves
p – Inlet valves under the influence of the quick closing governors
q – Driving engine of the briquette presses
r – Dryer
s_1 – High pressure condensate vessel
s_2 – Low pressure condensate vessel
t – Make-up water pump

FIG. 3. FLOW DIAGRAM OF THE PLANT

TURBINES

Two AEG 12,000-kw., 6000-v., 3000-r.p.m., 3-phase, 60-cycle turbo-generators, Fig. 2., designed for extraction back pressure operation are installed. They are designed for normal steam pressure of 1420 lb. per sq. in.,

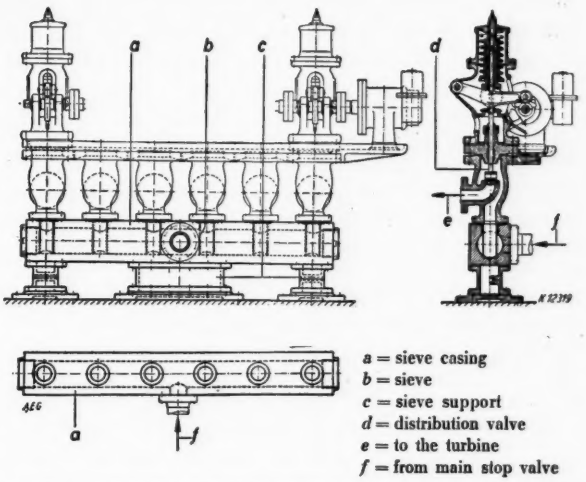


FIG. 4. TURBINE REGULATING VALVE AND STRAINER

842 deg. F., or a maximum of 1560 lb., 877 deg. F., for 15 min. At normal load, approximately 187,500 lb. of steam per hr. is supplied to the two throttles. At the end of the second cylinder this steam is reheated from 192 lb. gage, 428 deg. F., to approximately 545 deg. F. by Szamatolski steam reheaters. After reheating, 90,000 lb. per hr. of steam is used for driving the presses and the feed pumps. The balance is expanded to about 35.5 lb. in the lower pressure turbine and then used in the coal dryer. A flow diagram is shown by Fig. 3.

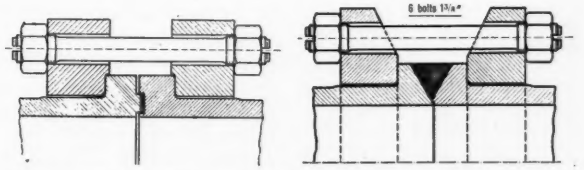


FIG. 5. TWO TYPES OF HIGH-PRESSURE STEAM JOINTS

One of the interesting features of the turbine is the regulating valve and strainer arrangement as shown in Fig. 4. This is bored from single block of wrought steel approximately 10 ft. long. Steam from the main throttle valve enters the side of the housing and flows through each strainer to the individual regulating valve under control of the governor.

Connections of the high-pressure steam piping are shown by Fig. 5. The first is a flanged connection using a steel gasket with asbestos and nickel rings, while the second is welded connection. These are electrically welded and the male and female joint at the bottom of the groove is to prevent the entry of weld bead into the interior of the pipe. These welded joints also have

flanges with half as many bolts as the regular flange connection. Feedwater piping was also welded with the weld reënforced by four welded fish plates.

Auxiliaries

Three Escher Wyss boiler feed pumps are installed. Two of the pumps with a maximum capacity of 260,000 lb. per hr. are driven at 3950 r.p.m. by geared turbines operating at 9350 r.p.m. The emergency pump has a maximum capacity of about 90,000 lb. per hr. and is driven at 3950 r.p.m. by a direct connected turbine. Turbines operate on 185 lb. 535 deg. F. reheat steam with a back pressure of about 50 lb. per sq. in. The exhaust goes to the steam dryer with the exhaust of the turbines.

The Szamatolski reheaters are located on the lower floor and consist of six heaters divided into two banks of three each connected in parallel. Reheaters are drained direct to an intermediate stage of the feedwater pumps at about 1110 lb. pressure gage. Final pressure of the reheated steam is regulated by means of a thermostat which throttles the outflow of condensate and controls the water level so as to increase or decrease the effective heating surface of the unit.

Turbine regulation and governing was designed to meet four conditions: constant extraction pressure and constant back pressure; constant extraction pressure and fluctuating back pressure; pure back pressure service at 36 lb. per sq. in. gage; pure back pressure at 192 lb. per sq. in. gage.

These first three conditions can be realized when the high pressure, middle pressure and low pressure turbines are in service, or when the high-pressure part is disconnected. When the briquette factory is shut down, only the low-pressure part receives steam and this from a neighboring 185-lb. gage boiler plant. At these times the high and intermediate-pressure sections receive only cooling steam. Under these conditions, the high-pressure boilers receive no return from the coal dryers and are not operating because of the scale-forming tendency of the chemically treated feedwater makeup.

This plant supplies current to three 500-kv-a., 6/16-kv. transformers to the Ilse ring mains; through three 1800-kv-a., 6/2-kv. transformers to the Renate and Eva mines; and to an 8000-kv-a., 6/60-kv. transformers to the network of the Niederlausitz Overland Central Station.

Potomac Electric Power Co. of Washington, D. C., is reported to be considering plans for the construction of a new power plant. The capacity of the Bennings plant has gradually been increased to 208,000 kw. and it is believed that further increase would require more condensing water than is readily available at the present site.

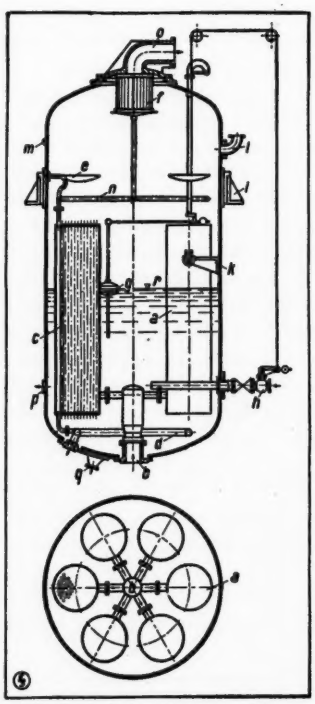
The company, therefore, subject to the approval of the proper authorities, has tentatively selected a location for a new plant at Buzzard Point near the confluence of the Anacostia and Potomac rivers. It is understood that the new plant will have an ultimate capacity of 200,000 kw. with an initial installation of between 35,000 to 50,000 kw. Besides supplying additional facilities for future growth of the district, the new plant at Buzzard Point will permit coal to be obtained by barge and if it is decided later to use fuel oil in the plant, this also can be transported by barge, whereas no barge transportation to the Bennings plant is possible.

Industrial Evaporator Design

AT THE GARTENFELD WORKS of Siemens-Schuckert, where the Benson boilers are installed, much of the 70-lb. gage process steam returns are too badly contaminated to be used for boiler feed, so industrial evaporators, heat transformers or steam converters, as they are variously called, are installed for the purpose of furnishing this 70-lb. process steam and still keep the high-pressure steam in a closed circuit. These evaporators work between the limits of about 120 and 70 lb. gage and are of a new design built by Weigelwerke, which has made it possible to save considerable space as well as reducing the first cost.

A section of these evaporators is shown. Each evaporator has six vertical stacks of heating tubes a with the heating steam introduced into the cylindrical heating system b from below. The water level is maintained by the float valve g operating the valve h. Condensate flowing down the tubes c rapidly desuperheats the entering steam. Condensate flows down into the common condensate pipe d.

The high rate of heat transfer causes lively ebullition which carries water particles upwards in the tubes as far as the baffle plates e. The insides of the tubes are thus continually wetted by water under rather high velocity which accounts for the exceptionally good heat transfer. Because of this, it was possible to make the heating surface of the evaporators only about half as large as would have been necessary in a unit of ordinary design.



a = Heating stack, *b* = Heating steam inlet, *c* = Heating tubes, *d* = Collecting main for condense water, *e* = Baffle plates, *f* = Steam trap, *g* = Float, *h* = Feed water regulating valve, *i* = Carrying lugs for outer casing, *k* = Suspensionf or heating stacks, *l* = Seating for safety valve, *m* = Seating for manometer, *n* = Collecting main for de-aeration of the heating tubes, *o* = Vapour exit, *p* = Drain for alkali, *q* = Mud outlet, *r* = Mean water level.

DETAILS OF EVAPORATOR

Before escaping, the steam is led to the steam trap f in which any water is separated by successive changes in the direction of flow. The individual heating stacks can be withdrawn from above by means of a crane. These heating tubes are slightly bent before assembly so as to provide better equalization with temperature changes.

Each of the two evaporators has a guaranteed output of 66,000 lb. steam per hour at 70 lb. gage and with a moisture of not more than 3 per cent when supplied with feedwater at 212 deg. F. During tests, the output was exceeded by 10 per cent with a moisture content calculated as about 1.2 per cent.

Costs of Diesel Power Plants

REPORT OF A. S. M. E. OIL AND GAS POWER DIVISION FOR 1930 SHOWS DETAIL COST DATA ON 81 PLANTS, CONTAINING 253 ENGINES TOTALING 146,865 HP.

TO OBTAIN DATA on costs of building and operating Diesel engine plants, the Oil and Gas Power Division of the A.S.M.E., through its sub-committee on Oil Engine Power Costs, Franz Eder, chairman, sent out again this year a questionnaire to existing plants asking for detailed data. A total of 81 plants returned complete replies and the data, covering the year 1930, were presented as a report at the National Oil and Gas Power Meeting at Madison, Wis., last June.

The report contains a discussion of units used, formulas for defining various quantities, fuel and lubricating oil data, cooling water systems, investment costs and types of load and presents the detailed tables of data on lubricating oil, fuel oil, maintenance and operating labor, and so on. These tables are too large to be presented here; the complete report may be obtained from the American Society of Mechanical Engineers, 29 West 39th St., New York.

Comparative costs for 1929 and 1930 for a number of the plants reporting are shown in the table herewith. Total net output for the 81 plants in the 1930 report is 271,414,817 kw-hr. produced by engines of 146,865 hp. The 1929 report included engines of a total of about 68,000 hp. Numbers identifying plants previously reporting correspond to the same plants in this report. Some plants, however, have reported for a three or four year period and a few for less than one year.

TABLE SHOWING COMPARATIVE OPERATING COSTS FOR 1929 AND 1930 OF A NUMBER OF DIESEL PLANTS

Plant Number	Total Installed B.H.P.		Total Net Output-K.W. Hrs.		Annual Plant Load Factor		Running Plant Capacity Factor		Plant Service Factor		Average Cost of Fuel Oil-Cents Per Gallon		Operating Costs Per Net K.W. Hr. - Mills: Fuel Cost		Lubricating Oil Cost		Attendance & Superintendance Cost		Cost of Supplies & Misc. Including Water		Cost of Engine Repairs		Cost of All Other Plant Repairs		Total of All Supply, Repair & Misc. Costs		Total Production Cost		Plant Number
	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	
43	11,640	11,640	22,591,027	26,221,176	45.4	46.1	6.99	70.4	48.1	57.8	4.25	4.37	3.82	3.96	0.69	0.53	0.60	0.94	-	0.21	-	0.67	-	0.05	1.04	0.93	6.14	6.35	43
46	6,900	9,250	24,909,500	27,444,480	69.4	60.7	83.3	83.6	76.3	67.2	4.92	3.62	4.48	3.35	0.19	0.23	0.83	0.61	0.32	0.19	1.33	0.96	0.22	0.25	1.87	1.39	7.38	5.58	46
91	3,450	5,250	7,585,725	8,187,025	46.6	53.7	52.0	63.1	72.8	82.4	3.90	4.09	3.72	3.95	0.48	0.29	1.18	1.06	0.16	0.16	0.22	0.33	0.07	0.04	0.45	0.53	5.82	5.83	91
92	2,500	4,900	6,662,389	10,027,739	44.1	56.8	71.6	65.0	61.6	61.1	2.15	2.09	2.20	2.25	0.55	0.33	1.24	0.92	0.17	0.28	1.85	0.26	0.12	0.06	2.14	0.58	6.13	4.06	92
52	5,330	4,580	5,722,032	7,257,703	31.1	33.5	65.3	75.2	45.2	45.4	5.58	5.70	5.38	5.30	0.56	0.38	3.83	2.83	0.88	0.74	0.74	0.56	0.40	0.48	2.02	1.76	11.77	10.29	52
45	4,250	4,250	7,442,350	6,908,500	35.8	34.9	72.5	69.5	43.6	42.4	5.23	5.29	5.04	5.18	0.09	0.09	1.85	1.77	0.06	0.04	-	1.01	-	0.10	0.92	1.15	7.70	8.20	45
2	3,450	—	No Reply To Inquiries		This	Year																							2
3	3,125	3,125	2,341,730	2,357,153	32.1	27.8	42.2	40.4	35.2	32.7	4.53	5.00	5.96	5.49	0.54	0.46	5.62	4.71	0.47	0.23	1.20	1.84	0.15	0.03	1.82	2.10	13.93	12.76	3
7	1,630	2,760	3,231,938	3,211,821	36.0	38.0	64.8	61.8	53.2	53.1	5.77	4.79	5.31	4.52	0.38	0.36	3.06	3.17	1.34	1.19	-	1.57	-	0.31	3.98	3.07	12.70	11.11	7
41	2,370	2,370	3,798,610	4,068,290	39.6	39.2	-	59.0	-	44.2	5.51	5.19	5.43	5.09	0.48	0.48	4.11	4.08	0.24	0.37	0.22	0.63	0.07	0.15	0.53	1.15	10.54	10.80	41
5	2,160	2,160	319,120	1,013,269	3.7	8.1	-	-	-	-	4.15	4.04	5.46	4.86	1.77	1.25	11.61	5.56	3.56	1.14	-	-	-	-	17.99	8.17	36.81	19.84	5
6	2,100	2,100	1,318,898	1,576,234	10.0	18.8	-	-	-	-	4.70	4.51	4.17	3.93	0.72	0.57	2.87	2.07	0.47	0.40	-	-	-	-	1.61	2.03	9.16	8.60	6
93	1,960	1,960	2,838,950	2,659,910	27.4	30.9	44.8	43.4	59.4	56.6	4.16	4.09	5.25	5.35	0.52	0.39	2.50	2.65	0.15	0.16	0.38	0.51	0.09	0.02	0.62	0.69	8.88	9.08	93
18	1,650	1,650	2,351,123	2,406,690	26.4	27.2	-	-	-	-	4.71	4.49	4.52	4.51	0.41	0.61	2.58	2.08	0.38	0.21	-	-	-	-	2.30	4.80	9.81	12.00	18
10	1,500	—	No Reply To Inquiries		This	Year																							10
11	1,350	—	No Reply To Inquiries		This	Year																							11
13	1,225	1,225	1,169,971	1,131,661	33.8	32.7	55.9	5.98	34.1	31.2	6.00	5.69	7.44	6.60	0.57	0.65	4.74	4.88	1.00	0.54	0.89	0.39	0.77	0.08	2.66	1.01	15.41	13.14	13
17	1,200	1,200	1,611,876	2,148,910	20.7	27.5	-	-	-	-	4.52	4.45	4.69	4.23	0.53	0.50	2.64	2.06	0.67	0.36	-	-	-	-	2.11	1.96	9.96	8.75	17
94	1,200	1,200	2,982,340	3,315,550	39.6	39.9	67.0	66.4	64.9	71.1	3.17	3.12	2.83	2.76	0.55	0.59	1.93	1.89	0.36	0.30	0.25	0.51	0.19	0.05	0.80	0.86	6.11	5.90	94
68	1,160	—	No Reply To Inquiries		This	Year																							68
95	1,120	1,120	1,675,810	1,408,900	28.0	23.3	48.0	50.7	57.8	45.4	3.23	3.12	3.76	3.53	0.32	0.21	3.60	3.54	0.32	0.38	0.36	0.68	0.15	0.02	0.83	1.09	8.51	8.66	95
96	1,100	1,100	1,133,027	1,215,181	17.0	24.3	49.1	61.5	37.7	32.2	3.61	3.56	4.30	3.54	0.99	0.66	3.87	4.28	0.54	0.43	4.39	0.78	0.19	0.21	5.12	1.42	14.26	9.88	96
97	1,080	1,080	2,027,967	1,816,136	39.9	38.9	51.1	57.4	67.7	53.9	3.18	3.36	3.48	3.87	1.51	1.61	3.01	3.98	0.30	0.19	1.56	0.26	0.10	0.08	1.96	0.53	9.96	9.99	97
98	1,000	900	1,677,817	1,774,521	35.1	39.9	63.2	64.5	47.9	56.7	5.57	4.73	7.31	6.37	1.05	0.90	3.05	3.28	0.45	0.60	1.68	1.00	0.21	0.31	2.34	1.91	13.75	12.46	98
100	740	740	1,247,150	1,459,540	49.7	35.1	59.9	60.9	50.2	58.1	3.36	3.50	4.14	4.32	0.73	0.68	4.69	3.70	0.41	0.47	0.37	0.82	0.20	0.06	0.98	1.35	10.53	10.05	100
67	720	720	1,163,600	1,098,900	64.0	58.4	79.1	82.9	33.7	30.3	5.94	4.97	6.03	4.73	0.55	0.71	1.60	1.70	0.21	0.23	0.04	1.03	0	0.02	0.25	1.28	8.43	8.42	67
19	700	700	603,260	710,280	29.8	34.9	-	-	-	-	4.50	4.13	5.32	5.72	1.40	1.26	5.40	4.96	1.07	1.07	-	-	-	-	2.24	4.05	15.36	15.99	19
106	600	600	750,419	1,435,434	17.5	35.8	-	-	-	-	4.66	4.49	4.75	4.18	0.66	0.27	2.66	3.09	0.61	0.65	-	-	-	-	2.62	2.52	10.69	10.06	106
103	390	590	772,985	995,145	40.8	38.0	53.3	60.2	67.8	61.2	4.63	4.20	6.04	5.43	0.99	0.93	5.82	4.60	0.56	0.49	0.85	1.73	0.28	0.43	1.69	2.65	14.54	13.61	103
102	480	590	577,980	591,620	24.7	27.4	39.8	42.7	58.1	56.1	3.41	3.25	5.22	4.78	1.81	1.36	8.51	8.32	0.57	0.34	0.58	0.28	0.30	0.35	1.43	0.97	16.77	15.43	102
101	540	540	668,871	768,521	35.5	49.1	53.7	60.5	40.3	40.6	3.56	3.79	4.35	4.56	1.43	0.90	6.39	5.62	0.83	0.35	2.67	0.74	0.57	0.03	4.07	1.12	16.74	12.20	101
104	415	—	Not Operated In 1930;		Load	Served By High Tension System																							104
99	600	400	1,358,689	366,005	31.7	-	72.9	84.9	49.9	19.4	3.09	3.18	2.86	2.81	0.41	0.24	3.04	3.12	0.42	0.63	0.60	0.61	0.21	0.02	1.23	1.26	7.36	7.43	99
24	400	—	No Time To Work Up Information To Fill Out Questionnaire																										24
105	370	370	272,138	372,330	33.1	33.4	51.7	58.5	35.9	35.7	3.20	3.14	5.97	4.77	3.69	1.09	14.60	11.00	1.76	0.97	6.59	0.44	0.90	0.17	9.25	1.58	33.51	18.44	105
28	330	—	Not Operated In 1930;		Using Purchased	Power																							28

Formulas defining various factors shown on the table are as follows:

$$\text{Running engine capacity factor, per cent} = \frac{\text{Engine output in gross kw-hr.} \times 100}{\text{Kw. rating} \times \text{no. hr. engine operated}}$$

$$\text{Running plant capacity factor, per cent} = \frac{\text{Plant output in gross kw-hr.} \times 100}{\text{Total rated kw-hr. of individual units}}$$

$$\text{Annual plant load factor, per cent} = \frac{\text{Plant output in gross kw-hr.} \times 100}{\text{Peak load in kw.} \times \text{no. hr. in period}}$$

$$\text{Plant service factor, per cent} = \frac{\text{Total rated kw-hr. of ind. units} \times 100}{\text{Total installed kw.} \times \text{no. hr. in period}}$$

In calculating plant service factor, it is necessary to take into account the fact that some units in a plant may have been installed for longer period than others.

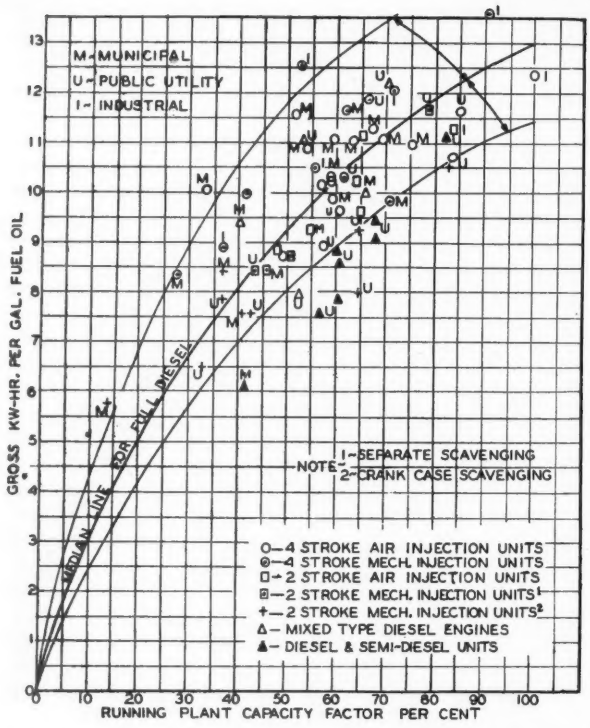


FIG. 1. FUEL OIL CONSUMPTION (PLANT AVERAGES ONLY) AT VARIOUS RUNNING PLANT CAPACITY FACTORS

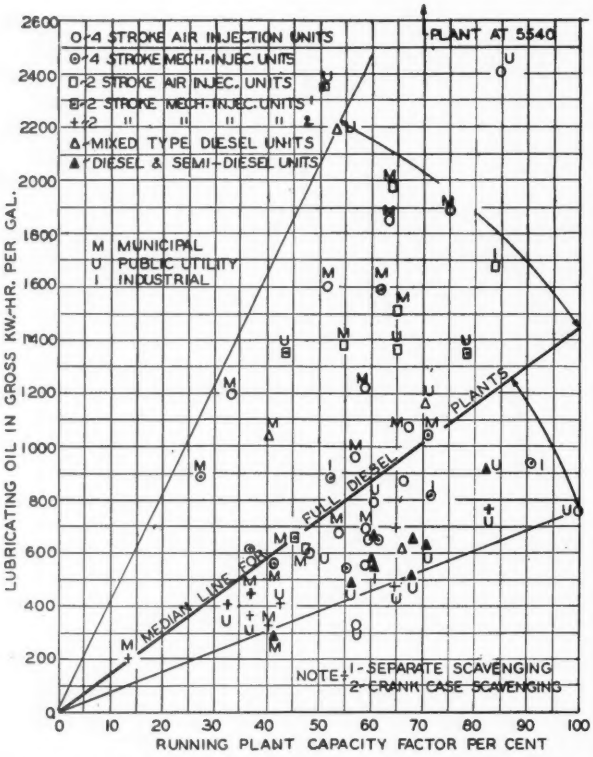

O-4 STROKE AIR INJECTION UNITS
⊙-4 STROKE MECH. INJEC. UNITS
□-2 STROKE AIR INJEC. UNITS
⊡-2 STROKE MECH. INJEC. UNITS¹
+-2 " " " " ²
Δ-MIXED TYPE DIESEL UNITS
▲-DIESEL & SEMI-DIESEL UNITS
PLANT AT 5540
M MUNICIPAL
U PUBLIC UTILITY
I INDUSTRIAL
FULL DIESEL PLANTS
MEDIAN LINE FOR
NOTE-1-SEPARATE SCAVENGING
2-CRANK CASE SCAVENGING
LUBRICATING OIL IN GROSS KW-HR. PER GAL.
RUNNING PLANT CAPACITY FACTOR PER CENT

FIG. 2. LUBRICATING OIL CONSUMPTION (PLANT AVERAGES ONLY) AT VARIOUS RUNNING PLANT CAPACITY FACTORS

In comparing this year's plant service factors with those of previous reports, it should be borne in mind that these adjustments were not always made in the past.

Data on fuel and lubricating oil consumption are summarized in Figs. 1 and 2. Types of plants illustrated are: Diesel 4-stroke cycle, air injection; Diesel 4-stroke cycle, mechanical injection; Diesel 2-stroke cycle, air injection; Diesel 2-stroke cycle, mechanical injection, separate scavenging; Diesel 2-stroke cycle, mechanical injection, crankcase scavenging; mixed type full Diesel; mixed Diesel and semi-Diesel.

Fuel and lubricating oil costs this year include costs for handling oil from cars to tanks. It was the committee's intention to have these handling charges included in the 1929 report also. Some operators, however, may not have included these expenses; this year they were specifically asked to do so.

Some confusion still exists as to what is included in the terms "supplies," "repairs" and "miscellaneous." Rather than set up another standard, the committee suggests definitions presented in the Uniform Classification of Accounts for Electrical Utilities published by the National Association of Railway and Utilities Commissioners.

The text of the report concludes with a helpful discussion of the items that should be included under investment costs and suggested definitions for types of load.

Operating costs for the two years, as shown in the table, display wide variations. In general, fuel oil costs have decreased slightly and the column showing fuel oil cost per kilowatt-hour shows corresponding decreases. Lubricating oil costs also show decreases in many instances.

The committee suggests the following definitions for types of load:

Complete Power:—The plant is run regularly alone when needed, without assistance from ony base or peak load service.

Base Load:—The plant is run at substantially full load whenever its capacity can be used, usually supplemented by a peak load service. When full or nearly full capacity cannot be used, the plant is shut down.

Peak Load:—The plant is run only when the load exceeds the capacity of the regular source of power.

Standby:—The plant is run only when the regular source of power is interrupted.

Seasonal:—Any of the above types of load may apply to a seasonal plant; that is, a plant operated normally for annually recurring periods, between which it is shut down.

ANNUAL REPORTS of Committee D-2 on Petroleum Products and Lubricants and several subcommittees, has just been issued by the American Society for Testing Materials. Included in this publication are 33 standard methods of test and 14 tentative test methods for products in this field. The book comprises 267 pages. Some standard methods included are: carbon residue of petroleum products; cloud and pour points; color of lubricating oils, of petrolatum and of refined petroleum oil; tests for the dilution of crankcase oils; flash points, gravity by means of the hydrometer, and the analysis of grease; electrical insulating oils; precipitation number of lubricating oils; sampling; saponification number; sulfur in gasoline and in motor fuels.

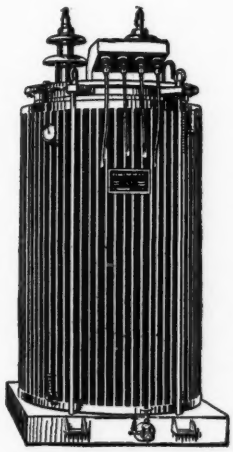
The price of the book is $1.25. It can be obtained from A.S.T.M. Headquarters, 1315 Spruce St., Philadelphia, Pa.

Care and Operation of Power Transformers

While a tranformer requires less care than almost any other type of electrical apparatus, neglect of certain fundamental requirements may lead to serious trouble. Operators therefore should find these rules formulated by the N E M A of value. . . . . .

PROBABLY NO MACHINE made by man has attained the degree of perfection held today by the alternating current transformer. Having absolutely no moving parts, its elements separated by such an ethereal thing as a magnetic field, this device nevertheless is capable of delivering at its output terminals well over 99 per cent of the power supplied to it. No other machine has such a high efficiency.

A machine of this degree of perfection, naturally requires little care in operation — having no moving parts, there is little to wear out. At the same time, it is not to be expected that a transformer once installed needs no care at all, for this assumption may lead to serious results. A transformer in common with many other electrical devices has two enemies, moisture and heat, and if care is not exercised to guard the transformer against these, failure will occur sooner or later.



In order to enable operators to give the proper care and attention to transformers, the National Electrical Manufacturers Association (NEMA) has prepared a complete set of instructions for the care and operation of both power and distribution transformers. These instructions cover both the handling of transformer during installation and their care when in operation. In this article, which is prepared from these instructions, we will discuss the methods of handling. The care during operation of transformers will be covered in a subsequent article.

Location

Water-cooled transformers depend almost entirely upon the flow of water through the cooling coils for carrying away the heat, so that the temperature of the surrounding air has little effect upon that of the transformers. For this reason, air circulation is of minor importance and water-cooled transformers may be located in any convenient place without regard to ventilation.

Self-cooled transformers depend entirely upon the surrounding air for carrying away their heat. For this reason, care must be taken to provide adequate ventilation. The number and size of air outlets in the room will depend upon their distance above the transformer and on the efficiency and load cycle of the apparatus. In general, about 20 sq. ft. of opening should be provided for each 1000 kv-a. of transformer capacity. Air inlets should have the same total area as the outlets. If the transformer will be required to operate for considerable periods at continuous full load, the areas of the openings should be increased to about 60 sq. ft. per 1000 kv-a. capacity.

Inspection Preliminary to Installation

Transformers are in first class operating condition when shipped by the manufacturer, i.e., they have been thoroughly tested for defects and are perfectly dry.

When received, examination should be made before removing from cars and if any injury is evident or any indication of rough handling is visible, railroad claim should be filed at once and the manufacturer notified.

Moisture may condense on any metal if the metal is colder than the air and if present, it lowers the dielectric strength and may cause a failure of the transformer; therefore, if transformers or oil drums are brought into a room warmer than they are, they should be allowed to stand before opening until there is no condensation on the outside and they are thoroughly dry.

Before being set up, a transformer should be inspected for breakage, injury or misplacement of parts during shipment and thoroughly examined for moisture. Transformers provided with taps should be checked to be sure that connections are made to the proper taps. In addition, all accessible nuts, bolts and studs should be tightened.

If transformers are water-cooled, the cooling coils should be tested for leaks at a pressure of 80 to 100 lb. per sq. in. Water, oil or preferably air, may be used in the coil for obtaining the pressure. The coil must be outside the tank, i.e., away from the coil insulation if water is used for the pressure test. When pressure is obtained, the supply should be disconnected and after 1 hour it should be determined whether any fall in pressure is due to a leak in the coil, or is in the fittings at the ends of the coil.

Transformers Shipped Filled with Oil

Each transformer shipped filled with oil should be inspected to see whether there is any condition indicating the entrance of moisture during shipment.

If the transformer is received in damaged condition, so that water or other foreign material has had a chance to enter the tank, the transformer should be emptied of oil and treated as though not shipped in oil and in no case may drying be omitted.

In all cases, samples of oil should be taken from the bottom and tested. The dielectric strength of the oil when shipped is at least 22 kv. between 1-in. disks spaced 0.1 in. apart. A new transformer should not be put into service with oil which tests below this value.

Each transformer shipped assembled but not filled with oil should be carefully inspected for damage in

shipment. A thorough inspection can only be made by removing core and coils from the tank. All dirt should be wiped off and parts examined for breakage or other injuries. All conductors and terminals should be examined to check their proper condition and position. The coil and core clamps should be tightened if necessary. The tank should be inspected and, if necessary, cleaned.

When a transformer is shipped assembled but not filled with oil, moisture may be absorbed during transportation. For this reason it is good practice to dry out all such transformers, especially transformers above 7500 volts, before being put into service.

Drying Core and Coils

There are a number of approved methods of drying out transformer core and coils, any one of which will be satisfactory if carefully performed; however, too much stress cannot be laid upon the fact that if carelessly or improperly performed, great damage may result to the transformer insulation through overheating.

The methods in use may be broadly divided into two classes:

1. Drying with the core and coils in the tank with oil.
2. Drying with the oil removed. The core and coils may or may not be removed from the tank.

Drying with Oil in Tank

Under the first class, the moisture is driven off by sending current through the winding while immersed in oil, with the top of the tank open to the air, or some other arrangement made for adequate ventilation. This may be done by the short circuit method.

This method consists in heating the windings and oil up to a high temperature for a limited time under short circuit with a partial load on the windings, the high oil temperature being obtained by blanketing the tank (or reducing the flow of water for water-cooled transformers). When a transformer is short-circuited in this manner, only a fraction of the normal voltage should be applied to one winding. In using this method, if the load does not exceed one-half or three-quarters full load, the winding temperature is not greatly in excess of the maximum or top oil temperature, so that high oil temperatures are safe without resulting in any deterioration of the insulation from local overheating. With good ventilation, the moisture, as it is driven off in the form of vapor will escape to the outside atmosphere and no condensation of moisture will take place on the underside of the cover or elsewhere in the tank.

The following table shows the short circuit current in per cent of full load current which may be used for this method of drying transformers, with the corresponding maximum allowable top oil temperature in degrees Centigrade. Less than 5 per cent of normal voltage will usually be required to circulate the current in the windings.

Short-Circuit Amp. in Per cent of Full Load		Maximum
Self-Cooled Transformers	Water-Cooled Transformers	Top-Oil Temperature
50	50	85 deg. C.
75	60	80 deg. C.
85	75	75 deg. C.

These temperature limits and loads must be strictly adhered to in order to obtain the desired results without danger to the transformers.

It should be noted that the higher allowable temperatures go with the smaller loads, that is, more blanketing or less water will be required to bring the oil temperature up to the point shown in the table.

Ventilation

During the drying run, additional ventilation to that ordinarily provided should be maintained by slightly raising the manhole cover and protecting the opening from the weather. The entire cover should be lagged with heat insulating material to prevent condensation of moisture within.

When to Discontinue Drying

Drying should be continued until oil from the top and bottom of the tank tests 22 kv. or higher between 1.0-in. square edge discs spaced 0.1 in., for seven consecutive tests taken 4 hr. apart with the oil maintained at maximum temperature for the load held and without filtering. All ventilating openings should then be closed and the transformer kept at the same temperature for another 24 hr. without filtering the oil and as before the oil should be tested at 4-hr. intervals. A decrease in the dielectric strength of the oil indicates that moisture is still passing from the transformer into the oil and drying should be continued.

Unless constant or increasing dielectric strength as shown by these tests indicates that drying is completed, the ventilators should be opened, the oil filtered and the drying process continued.

After the short circuit run is discontinued, the transformer should be operated for 24 hr. at approximately two-thirds voltage and at the same high temperature, making similar tests of oil samples and filtering the oil if necessary. After satisfactory two-thirds voltage test, full voltage should be applied for 24 hr. and the same tests repeated. Water-cooled transformers may require some water to hold the top oil temperature within the 85 degree C. limit during this test.

Drying with Oil Removed

Typical of the second class, i.e., drying with the oil removed, are the three following methods:

A—By internal heat.
B—By external heat.
C—By internal and external heat.

(A) By Internal Heat—For this method, alternating current is required. The transformer should be placed in its tank without the oil and the cover left off to allow free circulation of air. Either winding can be short-circuited and sufficient voltage impressed across the other winding to circulate enough current through the coils to maintain the temperature at from 75 deg. C. to 80 deg. C. About one-fifth of normal full-rated current is generally sufficient to do this. The impressed voltage necessary to circulate this current varies within wide limits among different transformers, but will generally be approximately ½ of 1 per cent to 1½ per cent of normal voltage, at normal frequency.

The end terminals of the winding must be used, not taps, so that current will circulate through the total winding. The amount of current may be controlled by

a rheostat in series with the exciting winding. Proper precaution should be taken to protect the operator from dangerous voltage.

This method of drying out is superficial and slow and should only be used with small transformers and then only when local conditions prohibit the use of one of the other methods.

(B) By External Heat—The transformer should be placed in a wooden box with holes in the top and near the bottom to allow air circulation. The clearance between the sides of the transformer and the box should be small so that most of the heated air will pass up through the ventilating ducts among the coils and not around the sides.

The best way to obtain the heat is from grid resistors, using either alternating or direct current. The temperature limits of ingoing air are 85 deg. C. to 90 deg. C. The transformer must be carefully protected against direct radiation from the heaters. Care must also be taken to see that there is no inflammable material near the heaters and to this end it is advisable to line the wooden box completely with asbestos. Also when forced air is used, suitable baffles should be placed between heater and inlet to the transformer inclosure.

Instead of placing the heater inside the box containing the transformer, it may be placed outside and the heat carried into the bottom of the box through a suitable pipe. Where this plan is followed, the heat may be generated by the direct combustion of gas, coal or wood, provided that none of the products of combustion be allowed to enter the box containing the transformer. Heating by combustion is not advocated except when electric current is not available.

This method, while effective, requires a much longer time than Method C.

(C) By Internal and External Heat—This is a combination of Methods A and B. The transformer should be placed in a box and external heat applied as in B and current circulated through the windings as in A. The current should, of course, be considerably less than when no external heat is applied.

This method is used occasionally where direct current only is available, a certain amount of current being passed through the high voltage winding only, as the cross-sectional area of the low voltage conductor is generally too large for it to be heated with an economical amount of direct current. The use of direct current for drying out is not recommended except where alternating current cannot be obtained. When this method of drying is used, the temperature should be measured by the increase in resistance method.

Method C is quicker than either A or B and has the great advantage that the insulation is heated much more uniformly.

There is no definite length of time for drying. One to three weeks will generally be required, depending upon the condition of the transformer, the size, the voltage and the method of drying used.

Insulation Resistance

The measurement or determination of insulation resistance is of value in determining the course of drying, only when the transformer is without oil. If the initial insulation resistance be measured at ordinary temperatures, it may be high although the insulation is not dry, but as the transformer is heated up, it will drop rapidly.

As the drying proceeds at a constant temperature, the insulation resistance will generally increase gradually until towards the end of the drying period when the increase will become more rapid. Sometimes the resistance will rise and fall through a short range one or more times before reaching a steady high point. This is caused by moisture in the interior parts of the insulation working its way out through the outer portions which were dried at first.

As the temperature varies, the insulation resistance also varies greatly, therefore the temperature should be kept nearly constant and the resistance measurements should all be taken at as nearly the same temperature as possible. The insulation resistance in megohms varies inversely with the temperature and for a 10 deg. C. change of temperature, the megohms change by a ratio of 2:1. Measurements should be taken every 2 hr. during the drying period.

Resistance Curve

A curve of the insulation resistance measurements should be plotted with time as abscissae and resistance as ordinates. By observation, the knee of the curve (i.e., the point where the insulation resistance begins to increase more rapidly) can be determined and the run should continue until the resistance is constant for 12 hr.

Precautions to Be Observed in Drying Without Oil

As the drying temperature approaches the point where fibrous materials deteriorate, great care must be taken to see that there are no points where the temperature exceeds 85 deg. C. Several thermometers should be used and they should be placed well in among the coils near the top and screened from air currents. Ventilating ducts offer particularly good places in which to place some of the thermometers. As the temperature rises rapidly at first, the thermometers must be read at intervals of about ½ hour. In order to keep the transformer at a constant temperature for insulation resistance measurements, one thermometer should be placed where it can be read without removing it or changing its position. The other thermometers should be shifted about until the hottest points are found and should remain at these points throughout the drying period. Wherever possible, the temperature should be checked by the increase in resistance method.

It is well to have a chemical fire extinguisher or a supply of sand at hand for use in case of necessity.

It is not safe to attempt the drying out of transformers without giving them constant attention.

According to a recent announcement by Great Lakes Aircraft Corp., Cleveland, Ohio, the company intends in a few months to make test flights with an airplane driven by a steam turbine. If these prove successful, process of refinement will be undertaken to make this a standard engine for larger aircraft. The steam plant, it is stated, is to have a capacity of 2350 hp. The turbine of the impulse type, expanding in three stages, operates at high speed, which will be reduced through special gearing. A multiple water tube type of boiler for 1000 lb. steam pressure will be fired by fuel oil.

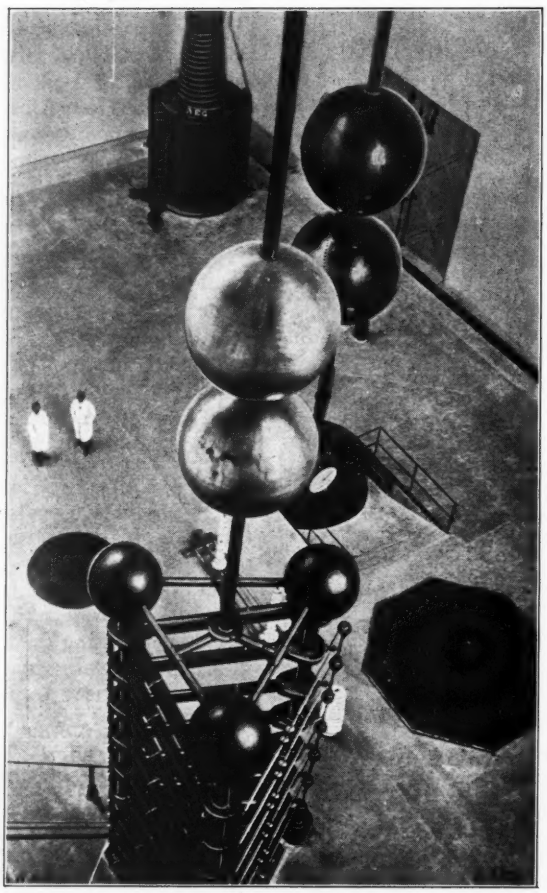
A Two Million Volt Laboratory

New Testing Plant For German Porcelain Works Has High Capacity as Well as High Voltage

By Hans H. Reinsch

IN THE DESIGN and construction of high tension electrical equipment, the question of insulation is one of greatest importance. In such equipment involving capacities of thousands of kilowatts, a puncture of an insulating point is comparable with the bursting of a dam. The reliability of a transmission system depends upon the strength of its insulation.

Naturally, before equipment of this character can be placed in service, it must be subjected to tests which will give reasonable assurance that the insulation is adequate to withstand the normal voltages encountered in actual service. To this end manufacturers have built testing plants for this purpose, gradually increasing the test voltages until voltages of one million were attained. But for the high voltage equipment used on modern transmission lines, test voltages of even one million volts are hardly adequate. Insulator strings intended for service at 220,000 v. or even 380,000 v. as is contemplated, require test voltages up to two million volts.



A CORNER OF THE LABORATORY SHOWING THE IMPULSE GENERATOR

In order to provide such test voltages, the Porcelain factory at Rosenthal in Germany has recently installed a new testing laboratory utilizing potentials up to two million volts.

This plant is designed on the basis of the most modern principles. All the knowledge resulting from years of experience in design was utilized; as a consequence this plant is one of the finest of its kind in existence. Single pole grounding is provided, permitting the required test voltages to be produced either between the poles or at the ground. In addition to having high potential, the equipment also possesses a sufficiently high energy capacity to permit study of the behavior of the arc.

In building this laboratory, it was necessary to build it of large dimensions since at two million volts the electrical energy will tend to puncture, or arc-over the air for a distance of 5 meters (16½ ft.); consequently a great deal of space had to be allowed for between the current carrying parts. The building itself has no windows, because practically all tests must be carried out in darkness in order to observe the slightest luminous phenomena. The laboratory contains two plants, the alternating current plant operating at normal frequencies, and the direct current impulse plant, permitting electrical transients similar to those in practice in the presence of atmospheric discharges to be applied on the insulation. There is also installed a high frequency plant operating at two million volts to ground.

Two transformers, each designed for one million volts to ground have been installed by the A E G-Berlin. The transformer is the only unit yet built that will yield one million volts to ground in a single tank. A single-tank transformer is the most advantageous arrangement when considering space requirements and also permits simple and convenient regulation. As it is still impossible to construct a single-tank transformer for two million volts to earth, it was decided to distribute this voltage equally between two transformers. The second transformer is mounted on a table insulated for one million volts to ground. Excitation is effected by way of an intermediate transformer mounted on an insulated platform at 500 kv. to earth.

The voltage is measured on the higher tension side

by means of a spherical spark-gap the spheres of which have a diameter of 2.4 meters (8 ft.). This spark-gap is also a new construction, inasmuch as the spheres formerly used for spherical spark-gaps did not exceed a diameter of 1 meter (3 ft. 3 in.). A direct current impulse testing plant was also installed. It had to be designed from the start for at least two million volts, for it is hardly possible to flash over a 100-kv. insulator string with an impulse of one million volts. The voltage up to 2.2 million volts is produced by a 15-kv.a. transformer and by charging a large number of series-connected condensers.

The measuring spark-gap for the direct current impulse plant is mounted on the structure holding together the three pillars (shown in the illustration). The actual measuring spark-gap consists of two spheres of 1.5 meters (about 5 ft.) diameter. The flashovers produced by this plant have similar physical characteristics to those of lightning or the over-voltages occasioned in overhead lines due to atmospheric effects. In order to obtain a persisting and powerful arc current, it is necessary that the alternator operate in a condition of over-excitation. For this reason, an air-core type reactor was connected in parallel with the alternator the capacity of which is 1000 kv.a. at one million volts. It is thus evident, that in addition to enormous voltages, this plant can also produce truly large amounts of energy.

Application of Unit Heater to Factories

PRECAUTIONS TO BE OBSERVED WHEN SELECTING AND INSTALLING UNIT HEATERS. BY C. C. HERMANN

CAST-IRON radiation is fast giving way to the more flexible method of heating, namely unit heaters. Instead of having the wall space lined with radiators of the cast-iron type or by a series of pipes of the pipe coil system of radiation, we find that this same wall space may be used for other purposes and the heaters hung overhead, in many instances direct from the steam line. This change promotes economy in heating installation. Labor of installation is materially reduced and the cost per square foot of radiation is considerably lower than with any other type of radiation. For example, a unit heater having a rating of 1725 sq. ft. direct radiation equivalent occupies a space of approximately 3 cu. ft. and this space is taken out of the air far above the floor of the plant out of the way of machinery, conveyors and other necessary equipment. The equivalent in wall radiation 38 in. high, three-tube, cast-iron type would be 80 ft. long using up this amount of wall space.

It is obvious that wall radiation increases the wall losses since one side of the radiation is close up against the wall and the heat must rise along the wall past the windows and theoretically, at least, follows the ceiling line circulating back again along the floor line.

To pipe 80 ft. of wall radiation involves considerable pipe and fittings since openings must be left for doors and windows. The condensate return lines must also be depressed beneath doors or carried above them either of which method involves certain fittings or trench construction below the door-way for the pipes. In the latter case, an additional pipe must be carried over the door-way in order to eliminate air binding.

Compare these points with the simple installation of a unit heater. Perhaps we have a steam line along the side of the room to be heated or perhaps it is down the center. We desire to install the unit heater, say 30 ft. from the wall and directed at an angle of 30 deg. from the wall. Our heater has a capacity of somewhat over 432,000 B.t.u.'s per hour or 1725 sq. ft. direct radiation. We must carry a 2½-in. pipe from the steam main to the heater overhead, hang the heater from the ceiling by two straps or rods and run a 1½-in. condensate line to the return main. In the steam line where it comes off the steam main we insert a gate valve and we must have another valve, a globe, in the return line between the trap and the return main also preferably close to the return main. The amount of piping and fittings is a minimum and the labor required to make the installation slight as compared with wall radiation.

It is an easy matter to go wrong on the installation of unit heaters. Usually the attitude exists that the unit may be installed anywhere and so it can, if, however, the maximum of efficiency is to be maintained one must pay attention to a few fundamentals. Following are a number of rules to be observed in the selection and installation of unit heaters which should prove helpful:

Choose a large number of small heaters rather than the large capacity heaters with large volume, high velocity fans. The specific reason for this is to avoid the sensible windage effect on the workmen and also on the product, if of a character that drying out must be avoided. In the latter class we have core-rooms where cores and molds are apt to be dried by the heated air blowing upon them. This principle also applies in printing plants where considerable paper must be handled and where any slight disturbance of the air will scatter the paper about the room. A good size heater is one having 1000 sq. ft. of direct radiation equivalent capacity and a fan tip speed quite low. Low speeds in fans of around 1140 and down to 585 are advisable. Of course, there are conditions which make the larger units advantageous; where the ceiling space is available, however, install more of the small units in preference to a few of the larger units.

Install the units along the wall, that is, a distance from the wall comparable with the air reach of the heater and at an angle of about 30 deg. from the wall. This is done to avoid a wiping action of the heated air on the wall. Thus installed, the infiltration of air will be diluted before it reaches the workmen and cold drafts will be eliminated from the workroom.

Install them at a height such that the heating zone will be where the workmen are but high enough so that there will be no sensible effect of moving air. The air velocity should be low enough so that it is hardly felt, yet moving with sufficient force to reach the floor before sweeping upward.

Wherever possible, mount the heaters direct from the main steam line as this results in low cost of installation and reduces the expense if later it is found advisable to move a heater. Always place a valve between the heater and the main and another on the return line.

Mount the heaters in such manner that they may be

turned if found advisable, since this permits adjusting of the heating zone. This is often found to be necessary, due to changes in operation and individual characteristics of workmen. Some workmen are so constituted that they must avoid even the slightest draft whether hot or cold.

Avoid mounting open heaters where they will interfere with natural ventilation, rather mount them so that natural ventilation will be assisted. Also never mount them in a dusty atmosphere, such as in a foundry, without providing them with a fresh air intake. Dust may clog up the radiators to such an extent that the heaters will not function. Their capacity is cut down materially by even a thin coat of dust and they must be blown out with compressed air at least once yearly. By providing a fresh air inlet, these heaters work admirably in foundries but without the duct they are not advisable.

Wherever possible, include some means for humidity control of the exit air from the heaters. This may be combined in the purchase of the heaters by specifying the right type of heater or it may be accomplished by providing a small steam jet opening in front of the heater so that the steam will be absorbed by the exit air. The right size orifice must be established by trial in each case but when once determined, it readily pays in increased comfort of the workroom.

A Strenuous Steam Engine Repair Job

PART III.* REVERSED ECCENTRIC CORRECTED, TURNING GEAR BUILT; REBUILT ENGINE IN SERVICE. BY GEORGE H. WALLACE

AT SOME TIME in the past, the exhaust valves had been set in the wrong position so that the wrong edges of the valves were used to function the exhaust steam. The design was such that under these conditions the passages were restricted. When properly set, there was ample area for the passage of the steam to the exhaust chest. Also, at some time or other, both of the low-pressure eccentrics had slipped, notwithstanding two good setscrews in each. In an effort to prevent this slippage (not always successful), keyways were cut in the eccentrics and corrugated keys 2 by 6 by ¾ in. were provided to fit corresponding corrugations in the shaft, the key being held in place by one of the two original setscrews.

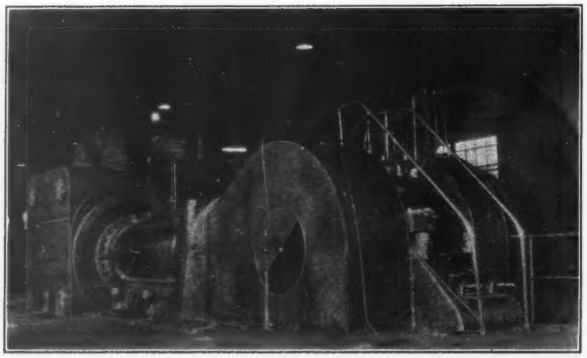


FIG. 10. SHE RUNS AFTER MANY WEEKS REPAIR WORK.

When the new eccentrics were made, naturally the location of the old keyways had to be followed, and when the exhaust eccentric was reversed in order to function the exhaust valves properly, the corrugated key was found to fit the corrugations in the shaft.

Additional keyways were provided in the new eccentrics and located on the center lines with a third setscrew to hold in place (temporarily) a 2 by 1 by 6 in. saddle key. Fortunately, after the engine was in operation, no changes were found to be necessary in the location of the eccentrics, so at an opportune time, the eccentrics were removed, keyways cut in the shaft and keys 2 by 2¼ by 6 in. were put in, to preclude possibility of trouble for all time.

But to return to the sequence of events on the repair job again. The engine was available from Friday until Monday, so the valve stems were laid out, the wristplates set for equal travel and the side rods taken off again, so the engine could be operated again on Monday as a single engine.

Old grout having been removed from under the exhaust chest (a laborious job), the space was regrouted by ramming in a stiff mixture of chet from both sides. This insured complete contact, whereas the original grout had evidently been too stiff for a poured mixture and had a contact of only about 6 to 8 in. around the edge of the metal.

The broken oil pan under the valve gear was patched and put on with a heavy copper gasket in the joint, which was necessarily uneven, and the joint caulked oil tight. Chet was rammed under the pan also.

To replace the 1½-in. foundation bolts which had been sheared off, consequently were not removable from the concrete, new holes were drilled two feet deep at the edge of the pan and new bolts grouted in, with a clamp clip to hold the pan rigid.

The rectangular box exhaust pipe, having been welded in a manner similar to the frame, was then put on, the expansion joint coaxed back somewhat to its former position and the condenser moved back till everything coincided.

Fracture in the vacuum breaker was such that repairs were difficult, but it was finally made serviceable. The circulating pump was gone over and the scale chipped off the runner and casing. The bearings and cooling pipes were renewed, and to insure safety in the future, the 5-in. priming valve was cut out entirely, dependence being placed wholly on the water from the spray pond for priming, even though at times it attained a temperature of 140 to 150 deg. F.

The repaired piston rod was then put in and screwed into the crosshead to its approximate location and the back head put on. The repaired tail slide was then put back in place, and the rod centered in the cylinder, mov-

*See Part I, page 901, Sept. 1, and Part II, page 980, Oct. 1.

ing the piston rod from end to end manually (another hard job), after which the new rod packing, weighing 400 lb. per set, was installed.

Previous to the accident, a four-feed cylinder oil pump used to lubricate the cylinder and its huge valves, was evidently responsible for the excessive wear of the exhaust valves and slippage of the eccentrics. A new 12-feed pump was purchased and a copper tube connection run to each end of each valve; one to each of the rod packings; and the remaining two feeds to the 24-in. inlet manifold on top of the cylinder.

Elevator Gear Serves as Turning Gear

Early in the process of rejuvenation, it was found that some method of turning the wheel, other than the time honored lever jack with a four-man attachment, must be devised. An old elevator gear was found and a spool put on, in place of the cable drum. This was bolted to the floor in front of the wheel and suitable wires attached.

On one end of a long 2-in. rope was attached a short length of heavy chain with a plug suitable to fit into the square holes in the wheel. With this device, the wheel could be rotated in either direction rapidly. For finding centers and similar fine work, the last few inches were negotiated with the jack.

It was now necessary to shut the engine down for a few days to make necessary connections preliminary to starting the repaired engine up again as a compound unit. The connecting rod was put on, and the engine rotated from one center to the other to equalize the piston clearance, the rod being rotated with a rope wrench and chain tackle as necessary. Clearance leads were taken through the exhaust ports, the valves being removed easily with the improvised crane.

This last task was to remove the temporary high pressure exhaust pipe that passed over the low pressure cylinder, and then to install the 24-in. inlet manifold. The oil tubes as mentioned above, and a hand oil pump for emergencies (though never used), was put in place, and the engine was ready to run. It was started up and in a few hours was carrying the load as usual. With the exception of the failure of a crosshead wedge collar and the urgent repairs previously described, the engine repairs were completely successful.

The unit continued in daily service without interruption for several months, during which time another engine in the same power plant was completely overhauled, main bearings rebabbited, pistons rebuilt, rods turned down, two new crosshead pins made, and ground into place, the rod bearings rebabbited and the throttle valve rebuilt.

All the valve stems were built up on the T heads and in the location of the packing. All the packing fixtures were refaced and reground as necessary and all new packing segments made. New packing was also made for returned piston rods. Three new carrier arm bearing pins were made to replace badly worn ones, and a number of new pins were put on the valve gears.

A STANDARD ATMOSPHERE is 29.91 in. of mercury when the mercury column is 32 deg. F. This is equivalent to 14.969 lb. per sq. in.

Combating Ice on Flashboards of Dams*

STEAM JET ICE SAWS, COMPRESSED AIR BUBBLERS AND ELECTRIC LAMPS WITH REFLECTORS ARE COMMONLY USED

WHERE FLASHBOARDS are used on dams and where there is any fluctuation of water level in winter, to prevent the ice from pushing over the flashboards or lifting them up a channel of open water must be maintained along the upstream face of the flashboards.

Three methods of maintaining this open channel were explained by companies submitting reports:

(a) Cutting open channels along the upstream face

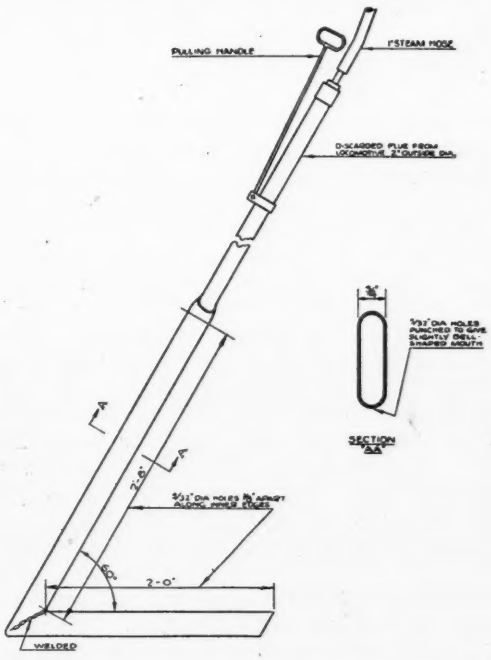


FIG. 1. STEAM JET SAW FOR CUTTING CHANNELS IN ICE

of the flashboards either by hand or by the use of steam jet ice saws such as that shown in Fig. 1.

(b) By installing bubblers along the upstream face of the flashboards, allowing the air released by the bubblers to bring the warm water to the surface, thus keeping the channel open.

(c) By electric heaters or lights arranged under reflectors which direct the heat down and prevent ice from forming under these heaters along the face of the flashboards.

With the present cost of labor, the cost of cutting open channels with saws and other tools is extremely high. Even with a steam jet saw, such as shown in Fig. 1, capable of cutting 40 ft. of 38-in. thick ice per hr., or approximately 127 ft. of 12-in. thick ice, these channels require continuous attention to be of any value.

Data submitted by the various companies on the use of bubblers and heaters for maintaining open channels are shown in the table. In the last column is tabulated

*From a recent report of the Hydraulic Power Committee, N.E.L.A.

TABLE SHOWING POWER FOR MAINTAINING CHANNEL BY AIR BUBBLERS AND LAMPS BEFORE FLASHBOARDS

USER	SIZE OF ORIFICE IN INCHES	SPACING OF ORIFICES IN FEET	DEPTH BELOW WATER SURFACE IN FEET	AIR PRESSURE IN LBS/SQ IN.	CU. FT/MIN. FREE AIR PER 100' OF CHANNEL	ENERGY USED WATTS PER 100 FT OF CHANNEL	REMARKS
MANITOBA POWER	.054	2	6	8	8		O.K.
HEMMINGS FALLS SOUTHERN CANADA POWER CO.	.0314	5	5	80	34	3400	FOR FLASHBOARDS - OK.
	.0314	5	15	80	34	3400	FOR SLUICEGATES - O.K.
ROCKDALE, MASS	.015	3	4	—	—	300	O.K. 2"x3" COMPRESSOR FOR 30' CHANNEL
NORWAY PLANT INDIANA HYDRO	.062 .310	10	18	10	6	250	O.K. LARGER ORIFICES AT END OF 225' LINE
ST. CROIX PAPER	.0156	3	3	60	7	550	OK.
KEOKUK IOWA			10	70	3.4	400	USED ON 30 FT. WIDE SLUICE GATES
LAURENTIDE QUE.	.080	4	12	6.5	17.5	700	USED ON 40 FT. WIDE SLUICE GATES
CALGARY POWER CO ALBERTA	.062	6	6	LOW			O.K. VERY SATISFACTORY
EEL WEIR ST. L. V. P. CO. N.Y.	.062	3	8.5	22	25	1440	O.K. VERY SATISFACTORY
MANITOBA POWER						17000	100 WATT CARBON LIGHTS ON 7" CENTERS - O.K.
CITY OF WINNIPEG						6000	500 WATT LIGHTS ON 10" CENTERS - OK.
TURNERS FALLS POWER CO. MASS.	.0156	3	12	10 20	7	500	O.K.

the energy consumed in watts per 100 ft. of flashboard, allowing for compressor and motor losses.

It seems entirely possible to maintain an open channel with either a high-pressure or low-pressure bubbler system, with as low as 300 to 400 w. of energy per 100 ft. of channel. The low-pressure system would appear more advantageous because of larger sized orifices, resulting in less danger of clogging, less wear, also lower maintenance on low-pressure compressors. Furthermore, there is less waste of power by low-pressure compressors, as the pressure actually required to force the air to leave the orifices under water is comparatively low. Some allowance must be made for loss in the pipe lines but the difference between the pressure actually needed and the pressure at which the air is compressed represents a loss.

Interesting facts brought out in connection with the use of lamps as heaters are that carbon lights are much more efficient than Mazda lights and that space heaters of equal wattage had very little effect. This may possibly be attributed to the red rays from the carbon lights.

When using either bubblers or lights under reflectors, drifting snow must be guarded against. Where the fluctuation in water levels is slight, the reflectors may be located close to the surface to avoid this trouble but where the bubbler system is used in locations exposed to wind and drifting snow, some form of covering, such as strips of canvas stretched over boards spanning the channel at 4 or 5-ft. intervals, will be found satisfactory. Snow fences have been tried for this purpose but with little success.

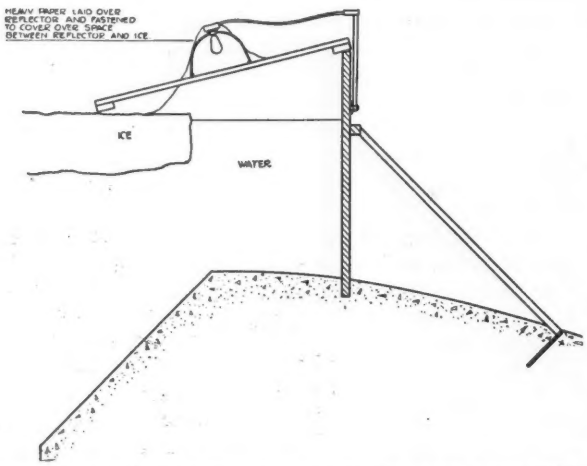


FIG. 2. ARRANGEMENT OF REFLECTOR AND LAMP FOR MAINTAINING CHANNEL IN FRONT OF FLASHBOARD

Is Your Power Plant Efficient?

By Frank H. Broome

SURVEYS of the power plants of many industrial plants have revealed that, in the large majority of cases, this part of the plant is the most neglected. Among the smaller plants, having not over 500 installed boiler horsepower, it might safely be stated that not over two per cent have made any attempt to secure efficient power plant operation and not over one per cent go as far as checking up with an actual heat balance.

One plant, which was examined, had, however, over a period of 4 yr., in spite of a 30 per cent increase in load, reduced power costs 25 per cent. Unless the efficiency of this plant had been increased, it would have been necessary to install an additional boiler to carry the increased load. The cost of improvements, such as CO_2 recorders, draft gages, high temperature flue gas thermometer, water meter, damper and blower regulator, soot blowers, power factor correction equipment, lighting generator and heat exchanger, together with proper maintenance, was all met by decreased cost of operation and this cost was much less than that of a new boiler. The two reasons for the improvements in this plant were first, a capable engineer and second, the confidence of the owners in their engineer.

In order that every plant owner or manager may be able to check up on his power plant, the following list of questions has been prepared and it is suggested that the owner or manager use them as a basis of a self examination into his own power conditions. If the problem is attacked from this angle, much more good will be obtained than if a general statement of facts was set forth. If the engineer of the plant cannot clear up any points in question, an outside engineer or the representatives of equipment suppliers will be able to do so.

The list of questions is as follows:

1. Do you consider your power plant as a necessary evil or do you realize that it is the very heart of your entire plant and if it shuts down, your plant will cease to operate?

2. Do you realize that your competitor, with an efficient power plant can operate cheaper than you, and therefore has a greater margin of profit?

3. Do you pay as much attention to your power plant as you do to other departments of your factory?

4. Are you acquainted with the generation of power? Do you speak the "language" of your engineer or fireman? Do you make periodic visits to your power plant? Are you proud of it? Do you show it to visitors?

5. Do you know that the proper man in charge of your power plant can save you considerable money if you will listen to him? Do you know that you have such

a man in your power plant? Do you have confidence in him? Do you recognize him as a specialist in his line? Do you furnish him with the equipment and supplies that he requests?

6. Do you read a magazine covering power subjects to find out what other plants are doing? Do you give an audience to sales representatives of companies handling power plant equipment? Do you let them study your plant and make recommendations for improvements? (Your engineer should be able to advise you as to the value of these recommendations.)

7. When your neighbor makes improvements in his power plant, do you go to see them and ascertain what savings the changes have produced?

8. Do you know whether you can purchase or generate electrical power more cheaply?

9. Do you know what proper fuel and fuel burning equipment and correct boiler settings will save you?

10. Do you know what proper feedwater treating and heating will save you?

11. Do you know what proper return of condensate will save you?

12. Do you know what soot blowers, damper regulators, CO_2 recorders, draft gages, flue gas temperature thermometer, boiler feedwater regulators and pressure regulating valves will save you?

13. Do you know what proper insulation on pipe lines, heaters, tanks, boilers and other equipment will save you?

14. Do you know what reliable traps, properly maintained, will save you?

15. Do you know that a heat exchanger will take heat out of hot waste water and put it into clean water for boiler or process uses with considerable saving?

16. Do you know whether the use of superheated steam in your plant will show economies?

17. Are you interested enough in your plant to want to know exactly how much heat you are really getting out of your fuel?

18. Are you interested in knowing what becomes of the power after it is generated?

19. Do you realize that if you do not keep your power equipment in a continuous good state of repair, your maintenance costs in the end are going to be extremely high and your operating costs at all times are going to be high?

20. Do you make repairs to your power plant during dull seasons, or do you wait until you are busy and making money, and the repairs must be made in a makeshift manner and at a high cost?

21. Do you realize that cheap power plant equipment and supplies are the most expensive in the end?

22. Do you know that some boiler protective devices are allowed because they were installed before the present laws went into effect, but are not as effective as the equipment specified by the present laws?

23. Do you get the full benefit of the service of your boiler insurance company? Do you study thoroughly the inspection reports of the insurance company? Although the insurance company may not insist that you correct certain conditions, but since it calls your attention to these conditions, do you realize that it is to your advantage to remedy them?

24. Do you realize that it is just as important to keep your power plant clean, light and dry as any other part of your factory?

25. If you are now spending $10,000 per year for fuel and if, by spending $3000 for improvements to your power plant, you can reduce your annual fuel bill to $7000, are you not increasing the value of your plant by $3000 instead of producing a large ash pile? And what about future savings which will result from this expenditure?

26. If you make various products and have a cost accounting system, do you know what part of your power cost to apply to each product?

27. If you intend to make improvements to your power plant, why not make them now and start right away to collect the dividends on what you spend?

Transformers Given Vacuum Treatment

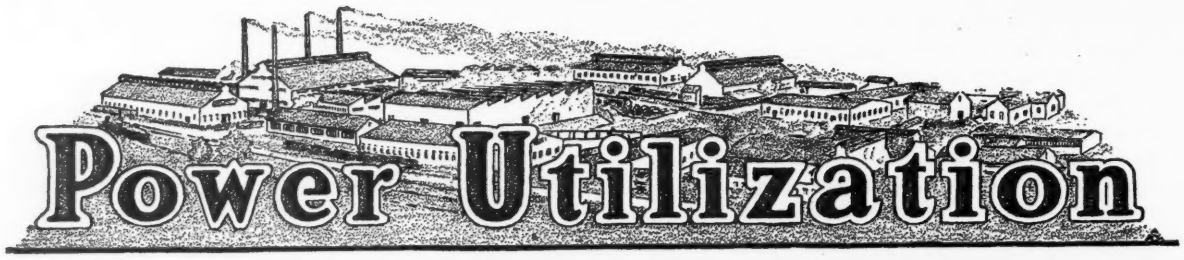
AN OIL BATH IN VACUUM TANKS is given the cores and windings of transformers in the Pittsfield plant of the General Electric Co. Air and moisture are first removed

from the assembled cores and windings in the tanks by vacuum pumps. When they are dry, transformer oil is pumped into the treating tank under sufficient pressure to saturate thoroughly all parts of the transformer, which is then removed and placed under oil in its own tank.

This process is necessary because the successful operation of a large high-voltage power transformer is to a great extent dependent upon its freedom from moisture and air bubbles, for any moisture or air in the insulation would lower its strength and failure might result.

TEXAS EMPIRE PIPE LINE CO. is operating on its system 10 large electrically-driven pump stations. At one of the stations located near Tulsa, Oklahoma, the company is pioneering in a practical demonstration of equipment and operating methods, involving the use of automatic switching and supervisory control.

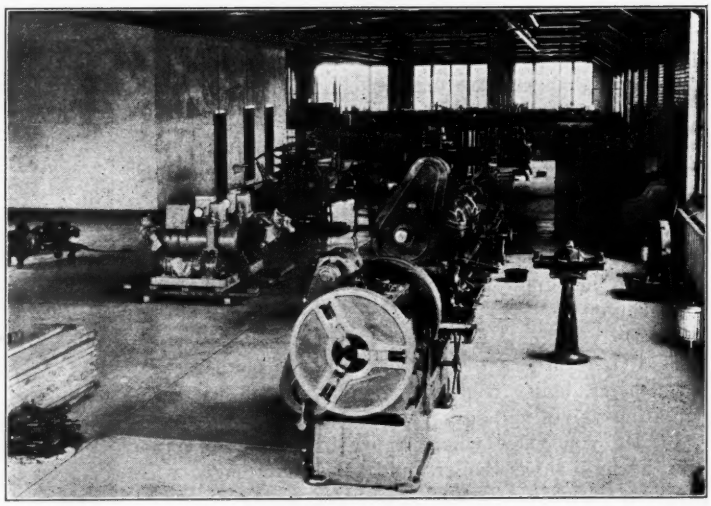
A study has been made to show the economies possible in case such equipment would be installed on the basis of a typical 451-mi. pipe line section with nine equally spaced pumping stations. An economic analysis by Westinghouse engineers shows a clear profit of 23 per cent on the additional investment required, after deducting 18 per cent carrying charge to cover interest, depreciation, taxes and insurance.



Organization for Plant Maintenance

Personnel
Training
Equipment

By Marin Phillips



Repair Shop for Maintenance

MAINTENANCE may best be defined as a service department to production. This means that repair departments must keep the plant machinery and equipment in first-class operating condition, with no delays that human foresight and ingenuity can prevent, or it is not living up to the tradition of a service department. While living up to and executing the laws of a service department, it has also to keep one controlling thought in mind. That is *cost*.

Plant maintenance may be divided into three distinct functions:

1. Work involved in keeping the machinery and equipment in operating condition through repairs and replacements.

2. The precautionary measures necessary to insure reliable plant operation, which cover a wide field of operation, such as foresight, study, inspection, selection and operation of equipment.

3. Costs which are the burden of items one and two and will depend on how well these items are planned.

Plan and Equipment

No continuous activity can function at its best without a program of operation to meet the plant condition or needs. A maintenance and repair program has to be built around the production department that it is to serve, which takes time, patience and study. It will start showing the greatest returns at about the time that discouragement creeps in to ask: "What is the use of keeping it up?" Today the maintenance program is founded on the items what to do, how and when.

For a maintenance department, the nucleus may be considered as follows:

1. A competent and thoroughly trained organizer to head the personal staff. This often falls to the plant engineer, due to his training in the different fields of plant activity. In the various departments, heads should do the scouting for details that will improve their departments.

2. Sufficient help to carry out the necessary work, mostly skilled help of various trades, as maintenance requires the work of good mechanics.

3. Proper and sufficient tools for carrying out the work in the shortest possible time without sacrifice of good workmanship. This will include such miscellaneous hand tools as it is the policy of the company to furnish; motor-driven hand tools adapted to the work involved, such as electric or air drills, riveting and chipping hammers, portable grinders, portable sanding machine and saw that are almost indispensable to the carpenter shop.

4. No maintenance department can function properly without a well-equipped shop, to be located as centrally as possible. This may not mean the center of the plant in all cases but it does mean that the shop should be near the greatest volume of work, with ample provision for getting the work to and from the shop. Proper handling requires overhead trolleys, chain falls, cranes and substantial trucking aisles.

Allocating of the workmen's duties and responsibilities is important and, in some cases, it will be necessary to furnish detailed instructions outlining the routine to follow.

In selecting workmen, care has to be exercised to pick for duties of a general nature, those with the initiative to carry out assigned duties properly. They should be given to understand that certain conditions or standards must be met.

Education of equipment operators gets less attention than it should, as the production department fails to realize the value of such training, while the maintenance departments feel that it is not their duty. I believe this training should fall to the maintenance department, as it is held responsible for the equipment upkeep; also maintenance men understand the need for careful operation of plant equipment better than the production department.

In training workmen to operate their machines and equipment properly, the first step is to select competent, interested workmen, then teach the difference between efficient operation and the abuse that runs up the cost of repairs. No fixed set of rules will apply to the training of all equipment operators, as each machine will have its own best method of operation. But proper lubrication and avoidance of undue sudden starting and stopping or the overloading of machinery are to be emphasized. Running certain types of machinery idle produces greater shock and wear than running loaded.

Equipment operators should be taught to report undue noises or irregularities in the operation of their machines. Most machine operators make out a report covering their day's work or production turned out. It would be advantageous to have space on this for reporting any trouble experienced in operation.

In most cases, equipment operators should be allowed to make only such adjustments as are essential to production set ups. Of course, exceptions can be made to any rule, such as that, for trucks and cranes or similar jobs where time permits, operators may be trained under the direction of the maintenance department to keep their equipment cleaned and repaired.

Care should be exercised when transferring repairmen and operators from one type of machine to another. Even though they may be expert on machines with which they are well acquainted, as to requirements of an unfamiliar machine training may be needed.

Selection of Equipment

As the maintenance department is held responsible for the continued operation of all machinery and equipment, it should visualize plant maintenance of the future. That is, in addition to present progress, what will the prevailing policy lead to next year? In other words, work to a definite goal on a rising curve of improvements with a declining curve of expenditure. To accomplish this requires careful selection of new equipment, through keeping abreast of new developments and their application to the plant.

In the selection of new equipment, consideration must be given to such items as the condition under which it will have to operate, automatic or manual control, direct drive or otherwise, ease of inspection and repairs, safety for operators, labor to operate and maintain.

Advice and experience of those responsible for operation, suggestions from the production department and in many cases from the manufacturers can be of great value in selecting the right equipment.

If, after study and investigation, the desirable equipment cannot be found, here is where the development personnel of the organization comes in for real service. The surest way to be right most of the time is to test out, as far as practical, by trial equipment to which the plant intends working with the betterment program. This will eliminate the danger of purchasing several units at one time and later being sorry for it.

Deferred Maintenance Is Costly

In the race for cost cutting, there is grave danger of eliminating certain work under the impression that it can wait until a later date. This tendency usually develops from an experiment through cutting down on labor and repairs. After getting by with it for a few months, some one will say: "Well, we are getting along all right; let's cut it some more."

To be sure, if a maintenance department is functioning properly, a great proportion of the work and repairs can be stopped for a considerable length of time and production go on, giving the impression that a drastic saving in maintenance costs has been made. But what about next year and the years to come? Putting off until tomorrow what should be done today is sure to come back strong and reflect on production later. Likewise, maintenance costs will soar again, due to excessive expenditures in a bunch, in order to restore repair standards to their former level.

Coöperation between the maintenance and production departments is a great help towards cutting maintenance costs and is also needed between the various branches of the maintenance department. At all times, endeavor should be made to plan work and equipment installation so that all concerned will know just what is going on.

Watching Costs

Repairs should be closely watched for chances to substitute new up-to-date equipment. As an example, a relay panel was purchased for a 10-hp. motor starting compensator for $18 to make a repair, as junking the starter appeared to be wasteful. But a new, modern, across-the-line starter could have been purchased for around $20 which would have required less maintenance and less floor space than the repaired compensator. The old starter could have been junked at a saving.

All superintendents and foremen should be provided with figures showing the cost of items used in their departments as well as the cost of operation, so as to conserve on parts and eliminate the use of expensive materials where cheaper ones will answer the purpose. In the search for cheaper materials, however, approved quality must be the deciding factor in their purchase.

Maintenance costs should be shown by a curve to create at a glance interest in the progress being made.

For measuring costs, a yardstick is necessary as a check. And so many detail items enter into maintenance costs, it is necessary to have a standard of comparison that is general. The most satisfactory standard is on a piece or tonnage basis. Comparing

one year's total cost with another doesn't tell much, due to changing conditions.

Maintenance may cost too much through lack of organized methods, or failing to anticipate need of materials and equipment far enough in advance to allow time for proper investigation and selection. Likewise, it may cost too much from a production standpoint through attempt to skimp on maintenance at the expense of continued reliable operation.

Manila Rope—Tests and Care

ROPE SHOULD be made from what its name implies, Manila hemp, the dried fiber of the leaves of wild banana, native to the Philippine Islands. Fibers are from 6 to 12 ft. long and vary greatly in strength; hence the variation in grades of rope. In low grade rope Russian hemp, jute and sisal fiber are sometimes used but should not be found in high-grade Manila rope.

As a test for detecting non-Manila fiber, the U. S. Bureau of Standards has approved the following: Cut a sample 12 in. long from the rope, separate it into strands and wash out oil with ether or alcohol. Immerse for 30 sec. in a bleaching powder solution to which has been added acetic acid; then rinse first in water, afterward in alcohol. After this washing, when exposed to ammonia fumes, Manila fiber will turn brown, all other fibers a cherry red.

Strength of Rope

This shows nothing, however, as to the grade or strength of the Manila fiber, which requires a tensile test. This should be made so that there is no kinking, chafing or cutting of the specimen. Strength and dimensions of good 3-strand medium-laid rope for Navy Dept. specifications are as given in Table I. Four-strand rope is some 6 per cent heavier but has about the same strength. Values for strength of New Zealand fiber rope will be 82 per cent of those in the table and for sisal fiber 67 per cent. It should be noted that size of rope is usually given by circumference rather than by diameter.

In use, loads should be much less than breaking strength. Safe values are given in Table II, rapid speed being 400 to 800 ft. a min.; medium speed, 150 to 300 ft. a min.; slow speed 100 ft. a min. and less. Values were compiled from Kent's Handbook and data of the National Founders Association.

When received, rope should be carefully inspected for abrasions, broken fibers and cuts. Dull appearance or discolored spots indicate age, inferior fiber or acid effect and call for careful tests, also for untwisting the rope at the spots to make sure that fibers are not damaged. If a piece of the yarn can be broken easily in the hand, the rope is likely to be unsafe to use. Good rope should be hard but pliable, with yellowish or greenish-gray silvery luster.

Treatment and Care

To keep rope in good condition it should be treated with a preservative and stored away from dampness but where it will not dry out and become brittle. Graphite and tallow may be used as a preservative but a liquid which will penetrate and lubricate the inner fibers is better. Special preparations are available for this purpose. Treatment and inspection should be repeated at intervals to ensure that rope remain in good condition. Storage by winding into loose coils and hanging up is usually preferred for small sizes. Large sizes should be kept on gratings which permit free air circulation.

In use, strain should never be put on a rope when kinked, as this severely overstresses the fibers and results in a weak spot which is liable to give way later. In uncoiling new rope, lay the coil on the floor inside end down and pull that end up through the center of

Approximate diameter in inches	Circumference in inches	Approximate weight of a 1,200-foot coil	Minimum breaking strength in pounds
6-thd. ¼	¾	24	700
9-thd. 5/16	1	35	1,200
12-thd. ⅜	1⅛	50	1,450
15-thd. 7/16	1¼	66	1,750
18-thd. 9/16	1⅜	78	2,100
21-thd. ½	1½	90	2,450
9/16	1¾	126	3,150
5/8	2	160	4,000
¾	2¼	198	4,900
13/16	2½	234	5,900
⅞	2¾	270	7,000
1	3	324	8,200
1 1/16	3¼	378	9,500
1⅛	3½	432	11,000
1¼	3¾	504	12,500
1 5/16	4	576	14,200
1⅜	4¼	648	16,000
1½	4½	720	17,500
1 9/16	4¾	810	19,500
1⅝	5	900	21,500
1¾	5½	1,080	25,500
2	6	1,296	30,000
2 1/16	6½	1,500	34,000
2¼	7	1,764	38,500
2½	7½	2,016	43,500
2⅝	8	2,304	49,000
2⅞	8½	2,580	55,000
3	9	2,916	61,000
3⅛	9½	3,240	67,000
3¼	10	3,600	73,000

TABLE I. DIMENSIONS OF MANILA ROPE AND BREAKING STRENGTH

TABLE II. SAFE LOADS AND SHEAVE DIAMETERS FOR VARIOUS SPEEDS

Dia. of rope in inches	Working load in pounds			Minimum diameter of sheaves in inches		
	Rapid	Medium	Slow	Rapid	Medium	Slow
3/8	25	50	120	15	5	3
1/2	50	100	250	20	6	4
5/8	70	140	360	25	8	5
3/4	105	210	520	30	9	6
7/8	125	250	620	35	10	7
1	150	300	750	40	12	8
1 1/8	200	400	1000	45	13	9
1 1/4	240	480	1200	50	15	10
1 1/2	320	640	1600	60	18	12
1 3/4	420	840	2100	70	21	14
2	560	1020	2800	80	24	16
2 1/2	800	1600	4000	100	30	20
3 1/2	1200	2400	6000	120	36	24

the coil. Do not uncoil from the outside. If a rope becomes kinked, coil it up left-handed, pass the end through the center of the coil and then coil right handed.

Wet rope should be dried out but not allowed to come close to high temperature sources of heat as this will dry out the oil. Do not allow a rope to freeze when wet as it will then break easily.

Sharp bends stress outside fibers and chafe inner fibers; that is the reason for minimum sheave diameters of Table II. and strain should never be put on rope when bent sharper than the sheave diameter for slow speed. Chafing against sides of blocks, or other surfaces and dragging along the ground will cause rapid deterioration. Grooves in pulleys should fit the rope without binding and should have smooth surfaces.

Rope should be tested from time to time with 3 times the load it is to carry. It should not be exposed to acid or strong alkali as these weaken the fiber. Rope of doubtful strength should never be used where a failure could have serious results.

Frequency Effect in Transformers

WHEN OPERATING at frequencies other than those for which they were designed, transformers undergo certain changes in character of action. As it is sometimes desired to use a transformer designed for 25 cycles on a 60-cycle circuit, it is well to have these changes in mind so that they may be considered when deciding whether or not such use is advisable.

As to losses, because magnetic flux changes are different, iron loss and magnetizing current loss will change, being less as frequency is increased. Copper loss due to load current will increase with frequency due to eddy current effect but this is usually small.

Drop in voltage through the windings will be increased, since reactance increases with frequency. As this is in the same ratio as copper load loss, the increase will be comparatively small. It will, however, be greater in large capacity equipment, since reactance is larger compared to resistance. Regulation, i.e. steadiness of voltage when load changes, will be poorer, especially for low power factor load and large capacity equipment.

As decrease in iron and magnetizing current loss will be more than the increase in copper loaded loss, for increase of frequency the total loss will be somewhat reduced and operating temperature will be lower, hence rating can be increased some 5 to 7 per cent.

If a 25-cycle transformer is to be operated in parallel with a 60-cycle, its different impedance may result in cross currents and this should be investigated. If the impedance of the 25-cycle transformer when operating on 60 cycles is within 10 per cent of that of the 60-cycle transformer, they will probably operate satisfactorily in parallel.

As an index to what may be expected, the following data from The Electric Journal will be found interesting, although the action of any given transformer may not check exactly with these data.

For a 25-cycle transformer used at 60 cycles, iron loss will be 50 to 60 per cent of normal; magnetizing current will be 10 to 20 per cent of normal. For capacity of 1½ to 25 kv-a., total copper loss will be 106 per cent, impedance 125 per cent and regulation at power factor unity will be 102 per cent; for power factor 0.8, 130 per cent. For capacity 37½ to 200 kv-a., total copper loss will be 111 per cent, impedance 185 per cent and regulation for power factor 1, 109; for power factor 0.8, 160. Occasionally a system designed for 50 cycles is changed to 60-cycle. The effects on transformer action would then be as follows: Iron loss 80 to 90 per cent; magnetizing current 40 to 60 per cent; total copper loss for 1½ to 25 kv-a., 101 per cent, impedance 109 and regulation at 0.8 power factor 108; for 37½ to 200 kv-a., copper loss 103 per cent, impedance 115 and regulation at 0.8 power factor 111.

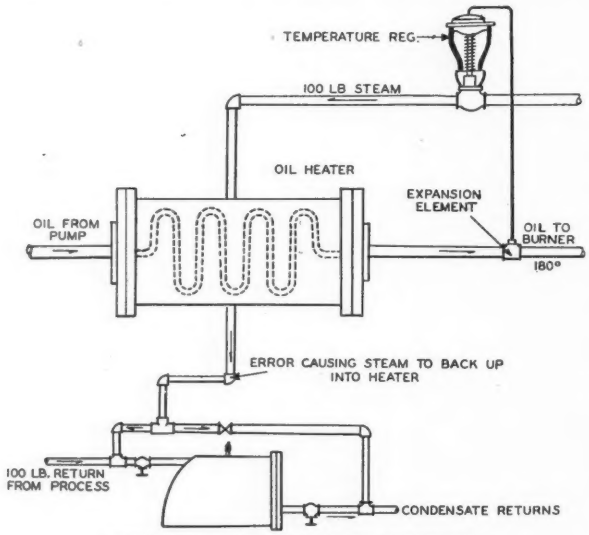
Since the reverse of these effects would be encountered, when operating a 60-cycle transformer on lower frequencies, the increase of magnetizing current and iron loss makes such operation impracticable, except that where stamped 50-60 cycles on the name plate, transformers may be used at either frequency. Even use of 25-cycle equipment for 60 cycles should be only temporary, as by rewinding for 60 cycles the transformer capacity can be raised to 240 per cent of the 25-cycle rating.

As an extreme emergency measure, two 60-cycle or 50-cycle transformers may be connected with primaries in series across a 25-cycle circuit and secondaries connected in parallel. Each should have voltage rating the same as the 25-cycle circuit and kv-a. rating equal to that needed for the load. Such use is extremely inefficient, is attended with some uncertainty of operation and should be discontinued as soon as possible.

ELECTRICITY and electrical devices are safe and dependable helpers when used with reasonable care.

Error In Trap Connections

INSTALLATION of a fuel oil system had to be completed in a short time, consequently the piping was hurriedly done. Wet steam at 100 lb. was trapped off from a process through a system already in use. Several men



TRAP PIPING THAT GAVE TROUBLE

doing the pipe fitting were connecting up an oil heater on top of the boilers and as the coil in this heater took steam from the 100 lb. header they decided to connect the discharge from this coil to the 100 lb. trap already in use. They assumed equal pressures and that the trap would drain the coil properly.

The only hitch in this idea came in when they neglected to consider the effects of the temperature regulator. When the heater was placed in service for the first time everything worked fine, the oil being cold and the steam regulator wide open. After a few minutes the oil temperature was noticed to be steadily rising. The regulator was set to close off the steam at an oil temperature of 160 deg. F. but the oil was over 200 deg. and still going up.

On examination of the regulator it was discovered that it had closed at 160 deg. F. The heater, however, was in such a position in relation to the trap that steam was continually rising into the end of the coil and displacing the condensate every time the trap dumped from the old line. As a result the temperature kept increasing and the expansion element exerting more and more force on the diaphragm with the valve already seated.

Before the line to the trap could be shut off, the regulator spindle was doubled up and the diaphragm broken. A system of this type should always discharge into a separate trap or have a syphon leg in the line.

Milford, N. J. H. M. SPRING.

Oil Leakage from Bearing

IN Power Plant Engineering of September 1, the letter on oil on windings was interesting. Oil leakage from armature bearings, even with the utmost precaution, is often difficult to prevent, due to the suction set up by the rotation of the shaft. This is particularly the case when the bearing has worn.

I have overcome this difficulty by grooving. A groove is cut in the white metal of the bearing right around its circumference. At the lowest point, a hole is drilled through to the outside of the bearing, so as to allow any oil which collects to drain away. Any oil which creeps to the end of the bearing will be thrown into the groove by centrifugal force and be drained away. I have found this quite effective. The surface of the bearing will be very little reduced and enough lubricant will escape to lubricate the small piece of bearing between the outer edge of the groove and the bearing edge.

Herts, England. W. E. WARNER.

Sand-blasting Boiler Tubes

IN THE September 1 issue, Mr. Noble writes against the use of sand-blasting the tubes of return-tubular boilers. I have found that it does no harm if used judiciously. I do not recommend its use instead of soot-blowers, but circumstances often require more than ordinary steam blowing to get clean tubes. By clean tubes, I mean those free from soot and scale due to soot deposits. The "gun-barrel" polish spoken of by Mr. Leach is not recommended. How often it is necessary to use it is best determined by the condition of the tubes. The amount of the soot deposit and the effectiveness of the soot-blowers should determine the frequency of sand-blasting.

I have had return-tubular boilers with rear-end soot blowers that would form a scale deposit on the rear end of the tubes due to the vapor from leaking soot-blower valves. It seemed almost impossible to keep these valves tight for any length of time. The

blowers would not remove this deposit but I found the sand-blast effective for doing so. Some experimenting had to be done to determine the minimum amount of sand needed and the frequency of blowing. Such trials should always be made when sand is used. A simple way of applying the sand-blast and one by which the sand can be measured is to make a simple ejector, but instead of having the suction at the bottom have it at the top and insert a funnel. Depending on the conveniences one has for using it, a gate valve in the line to shut off the sand is optional. An old valve should be used.

A shut-off should be placed in the air line to use when changing the blower from one tube to another. Three iron bows should be welded to the discharge pipe in such a way that they hold the pipe central in the tube when inserted in it. That blower which gives an abrasive action for the greatest distance from the end at which it is applied and for the full circumference is best. My experience has been that the described type gave the best results.

Keyport, N. J. GEO. B. LONGSTREET.

IT SEEMS that I have raised quite some argument in connection with sand-blasting boiler tubes. I would not recommend the use of it daily or even weekly, but as used, that is twice a month at wash out periods. I hardly think there will be as much wear on tubes as there would be if we used a turbine which was at one time the practice. My expression, "Clean as a gun barrel," was used figuratively, not literally. What I wished to convey was, that all soot crusted on the tube surface was swept away. Caution and judgment must be exercised in its use as well as in other things.

Use of the sand blast is supplemented by daily blowing of tubes in the regular manner. The sand blast is for the removal of incrustations which ordinary blowing will not remove. We are careful to get a straight line blow through the tube and just enough sand is admitted to clean the tube without scoring.

We are burning a low volatile coal which runs about 1.5 per cent sulphur. The tube deposit runs more to fly ash than soot.

So far as metal removal is concerned, I doubt very much whether there is as much as would be the case, if we used a turbine or even a scraper if set tight enough to the tube walls to get the same degree of cleaning.

Mechanicville, N. Y. R. F. LEACH.

Defrosting Direct Expansion Joints

METHODS OF SCRAPING frost from direct expansion coils are expensive and not entirely satisfactory. The more modern way is to defrost with the discharge gas, allowing the hot gas to flow into the coils a sufficient length of time to loosen the frost next to pipe. Then by hitting the pipes with a piece of 2 by 4 lumber the frost readily falls off with practically no moisture. Where a small amount of moisture does get to the floor in very low temperatures rooms it can be readily loosened from the floor by sprinkling it with salt. A 2-in. coil should have a 1-in. discharge gas connection just back of expansion valve. When ready to defrost, the expansion valve should be closed and the suction valve cracked just sufficient to hold the gas so that a pressure will form. Where rooms are carried at around +6 deg. F. coils have been cleaned with a rise of temperature of 4 to 5 deg. F., which is regained almost as quick as lost, due to the higher efficiency of the clean coils.

This same method can be used on small units by merely reversing the gas through the pump-out system, allowing expansion valves to stay as they were used. This method is very practical and no harm can occur therefrom.

Kansas City, Kan. J. F. STALEY.

Fuel Oil Storage

I BELIEVE that emphasis should be placed on the point mentioned by Mr. Custer in the July 15 issue about underwriters' rules, state and local laws and ordinances. These cannot be watched too closely by the engineer, if he is to avoid trouble. In New York, for instance, the regulations are very complete and, where it is required that oil be stored below the level of the burners, it is sometimes quite a trick, especially in an office building where the plant is usually in the lowest part of the structure. Another ordinance requires the transfer pump to be above the tank so that it must suck the oil out. As a rule, ordinances and laws are the result of many years' experience and, although they may appear to be foolish at times, there is a good reason for them. Even where they are not enforced, they should be complied with as a matter of safety.

The requirement that a vent pipe 1½ in. diam. must be carried to 12 ft. above the filling pipe and 3 ft. from any building opening and provided at the top with an elbow fitted with a No. 40 noncorrosive wire screen, applies to day tanks, which should also be supplied with an overflow pipe back to the storage tank, as should drip tanks.

Another thing, I think that an elevated day tank is never justified, even where no code or insurance regulations are to be complied with. The auxiliary engine pump can lift the oil a short distance to the small tank on the engine and avoid the possibility of flooding the engine room, if something goes wrong. I think a float valve arrangement from the day tank to the engine should not be allowed.

Rules of the National Board of Fire Underwriters provide that: "Gravity feed from supply tank to engine is prohibited. Tanks or other reservoirs for providing a supply of oil within the building shall have a capacity of not more than 60 gal. when not of the pressure type. The tank shall be filled with an approved pump connected by full weight iron or steel pipe to the main supply tank. Tanks shall be provided with ample overflow pipes connected to the main tank. Oil shall be drawn from the auxiliary supply tank by an approved pump operated by the engine. Pipe connections below the oil level in any tank having a capacity in excess of one gallon are prohibited.

"Tanks or receivers of the pressure type shall have a capacity of not over 10 gal., shall be provided with a reliable gage and with a pressure relief valve set to operate at a safe pressure and connected by an overflow to the main tank. These receivers, when installed with engine supply pipe connections below the oil level shall be arranged so that the oil will automatically drain back to the main storage tank when the engine stops, leaving not over one gallon, where necessary for priming.

If the engine supply pipe is connected to the tank above the oil level, automatic release of the pressure without the draining of the tank may be permitted.

"Fuel supply tanks shall be large enough to contain fuel for running the engine at full load for a period of at least 4 hr. Fuel oil tanks having a liquid capacity not exceeding 10 gal. may be mounted at the engine, if tanks are of approved construction and rules and precautions are rigidly observed. Fuel shall be drawn from the tank by a suction pump or other approved means which shall have check valves located as close thereto as convenient."

Safety is important to the engineer and operator but code regulations are likely to be of more interest and their neglect troublesome to the owner, hence local regulations should be complied with. It is embarrassing to get all ready to start, then have the inspector hold things up until changes, sometimes costly ones, are made. Neither does it increase one's prestige with the powers that be.

Brooklyn, N. Y. P. F. Rogers.

Cause of a Burned Out No Voltage Coil

In a machine shop recently, the solenoid coil operating the no-voltage release on an alternating current starting switch burned out. A new coil was fitted but this also was found to heat excessively. Furthermore it was possible to get a shock from the metal work of the switch in spite of the windings showing a high insulation resistance.

After some investigation, the whole trip gear was dismantled and it was found that the movable iron core was attached to a brass spindle on which there was a spiral spring. When the switch was alive, this spring had been acting as a secondary winding, with the result that a current flowed in it and the connected metal work. This caused the coil to take more current, finally resulting in the destruction of the coil. The spiral spring had evidently been fitted by a switch repairer at some time, as it was not a standard part of the switch. After the spring had been removed and the trip gear adjusted, the coil ran quite cool and there was no further trouble.

Herts, England. W. E. Warner.

Dry Air for Automatic Sprinkler Systems

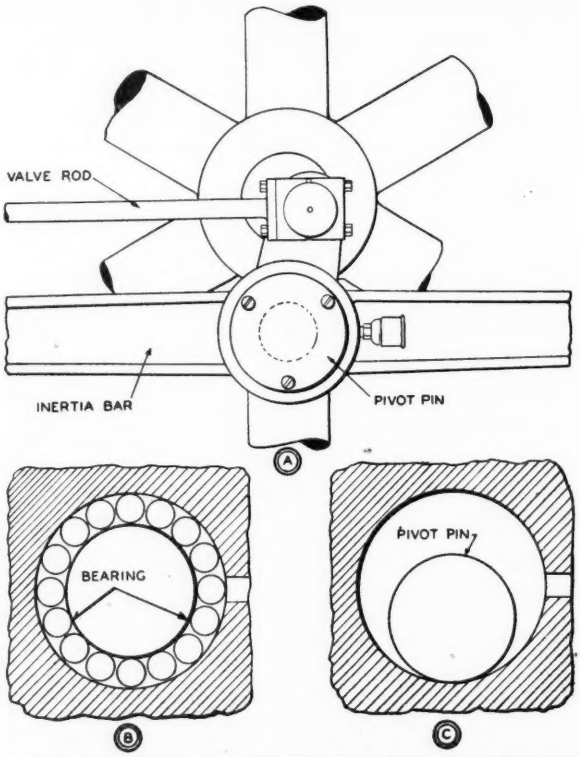
What is known as the dry pipe sprinkler systems are often a source of trouble in the winter months when the moisture from the air condenses and causes lines to freeze and burst. Where refrigeration is at hand on a large scale at a low temperature, it pays well to draw the air used on the sprinkler system from these cold rooms. Compressing this air and discharging it into dry pipes will entirely eliminate moisture. Where no large unit is at hand and an extensive sprinkler system is in use, it will often pay to have a small refrigerating unit connected to dry the air before or after compression. The former is more economical as there is less heat to remove. Sufficient refrigerating piping to dry the air will avoid many bursted pipes and fittings as well as reduce fire hazards.

Kansas City, Kan. J. F. Staley.

Governor Pivot-Pin Bearing Deranged

Going over a power plant containing a 150-hp. engine equipped with an inertia governor and direct-connected to a direct-current dynamo, the new engineer in charge found that the engine would respond only slowly to wide variations of load. The governor gave fairly good regulation under a constant load but, every time the load varied as much as ten amperes one way or the other, the engine would stagger for some seconds before the governor could adjust itself to the change.

The governor's inertia bar swung on a pivot pin attached to a spoke of the flywheel, as indicated in Fig. 1A. The new operating man assumed that the trouble



A. ARRANGEMENT OF GOVERNOR PARTS. B. PIVOT-PIN BEARING AS DESIGNED. C. PIN AND BEARING AS FOUND

was due to clogging of the pivot pin's roller bearing by the heavy grease used for lubrication but, when he removed the collar plate from the end of the pin, he found that this assumption was wrong. The lubrication was all right—but someone had taken out the rollers.

The assembly of pivot pin and roller bearing is shown by the drawing Fig. 1B. Removal of the rollers had caused the pin to rest on the periphery of the hole in which the entire assembly previously had been housed, as indicated by the drawing to the right. That the governor had been in this condition for a long period was shown by the fact that the pivot pin was worn and had hollowed out a depression at its line of contact to a depth of nearly ⅛ in. as seen in Fig. 1C. Truing up the pin in the lathe and inserting a proper set of rollers restored the governor to good working condition.

St. Louis, Mo. D. J. Altizer.

Carbon and hydrogen are the desirable elements in coal; ash and sulphur, the undesirable ones.

Generator Sizes

AT OUR HEATING plant we have three 3100-sq. ft., 165-lb. gage, water-tube boilers fired by fuel oil. These boilers, which can be operated at 200 per cent rating, 78 per cent efficiency moisture about 4 per cent, supply a steam heating load of about 20,000 lb. per hr.

In the near future, we expect to install turbo generators and expect to bleed steam at 30 lb. absolute for heating. Assuming the boiler is operating at 200 per cent rating, what would be the maximum kilowatt load we might expect when bleeding 20,000 lb. per hr. or when operating condensing with no bleeding?

If we installed superheaters to give say 50 deg. F. superheat, what change would this make in the turbine water rate? A. F. S.

A. At a pressure of 165 lb. gage or 180 lb. abs., 96 per cent quality steam, has a heat content of 1162 B.t.u. per pound. When expanding adiabatically to 30 lb. abs. or 15 lb. gage, the heat content would be 1032 B.t.u. per pound, and expanded to 27 in. vacuum, the heat content would be 862 B.t.u. per lb. This gives an adiabatic heat drop of 130 B.t.u. per lb. for steam extracted at 30 lb. abs. and 300 B.t.u. for steam going to the condenser. A kilowatt-hour is equivalent to 3415 B.t.u. and assuming a generator efficiency of 90 per cent and a turbine Rankine ratio of 60 per cent, 1000 lb. of steam would generate—

$$\frac{1000 \times 130 \times 0.60 \times 0.90}{3415} = 20.6 \text{ kw-hr.}$$

That is every 1000 lb. of steam extracted would develop 20.6 kw-hr. For the steam going to the condenser—

$$\frac{1000 \times 300 \times 0.60 \times 0.90}{3415} = 47.4 \text{ kw-hr.}$$

Each 1000 lb. of steam going to the condenser would develop 47.4 kw-hr.

A 310-hp. boiler operating at 200 per cent rating would generate approximately 20,000 lb. per hr. and if we assume two boilers are operated and one kept as a standby, the maximum steam output would be 40,000 lb. per hr. Straight condensing this would generate 47.4 $\times$ 40 = 1896 kw., but if 20,000 lb. per hr. of steam were bled at 30 lb. abs. for the heating system, the power generated would be (20.6 $\times$ 20) + (47.4 $\times$ 20) = 1360 kw.

With 180 lb. absolute, 50 deg. superheat steam, the total heat content is 1227 B.t.u. After adiabatic expansion to 30 lb. abs., the heat content would be 1086 and after expansion to 27 in. of vacuum, it would be 907, giving a heat drop of 141 B.t.u. per lb. in the first case and 320 B.t.u. per lb. in the second. Assuming a generator efficiency of 90 per cent and the turbine Rankine ratio of 65 instead of 60 per cent because of the superheat, each 1000 lb. of steam extracted at 30 lb. abs. will develop

$$\frac{1000 \times 141 \times 0.65 \times 0.90}{3415} = 24.1 \text{ kw.}$$

Each thousand pounds of steam expanded to condenser pressure will develop

$$\frac{1000 \times 320 \times 0.65 \times 0.90}{3415} = 54.7 \text{ kw.}$$

In this case 40,000 lb. of steam straight condensing would develop 54.7 $\times$ 40 = 2188 kw. or with 20,000 lb. bled at 30 lb. abs. the total power would be:

$$(54.7 \times 20) + (24.1 \times 20) = 1576 \text{ kw.}$$

It must be kept in mind, however, that 165 lb. 96 per cent quality steam expanded through a reducing valve to 30 lb. will be close to dry saturated steam, whereas the steam extracted from the turbine at 30 lb. will have a quality of about 86 per cent when expanded as in the first case or a quality of about 92 per cent in the second case with 50 deg. F. superheat at the throttle. Allowance would have to be made for this when figuring the quantity to be supplied to the heating system.

Depending upon local conditions, a 1500, 2000 or 2500-kw. machine might be installed and the exact water rate would have to be obtained from manufacturers. An extraction machine might be advisable, although it is probable that a 2000-kw. straight condensing with a 500-kw. back pressure combination or two 1000-kw. straight condensing and one 500-kw. back pressure machines might be desirable, depending upon costs, load, plant layout and the necessity for continuous power supply.

Purging CO_2 Systems

HOW CAN YOU tell whether there is air in a CO_2 system and how do you proceed to purge the system of air that may be present?

G. S.

Air and noncondensable gases result in increased condenser and receiver pressures. If the condenser pressure exceeds the theoretical pressure corresponding to the temperature of the cooling water leaving the condenser, the system should be purged. CO_2 is heavier than air and other gases which may collect and will sink to the bottom. The purge connection should be at the top of the receiver or condenser. It should be opened until a slight bluish tinge appears. This bluish tinge indicates the escape of CO_2 and further purging results in a useless loss of refrigerant.

Editorial Comment

"I Take All Knowledge for My Province"

The more you learn about the modern scientific research worker, the more you will be convinced that all knowledge is a whole—a unit. The man who said, "I take all knowledge for my province," (was it Voltaire—or wasn't it?) was considered to be somewhat arrogant in his assumption that any man could be good enough to take it all.

Yet the modern scientist does this very thing. By one of the most stupendous feats that the human mind has ever performed, the scientific world over a period of years has succeeded in building up a theory of the relations of space and time and matter and energy that reduces them all to one essential thing—electrons in motion.

This theory can be comprehended by the non-scientist and most interesting of all, it can be made to work for the human race. Into it are woven all the data gleaned by astronomers, biologists, physicists, mathematicians, philosophers and even artists. In short, it is the theory that all things are but varying manifestations of one thing—the fundamental energy of the electron itself.

There are skeptics who say that the whole of modern science is too plausible, that it can't be as fundamentally simple as all that and that there must be a serious flaw in it somewhere. But see what modern science does with its theories. It predicts by mathematical computations what is likely to occur in a given case and then, when the method is carried out in the experimental laboratory, the observed results confirm the prediction. In this process, also, many new tools are provided with which scientific research workers may probe farther and farther into the mysteries. Of most importance for the layman is the fact that so many of these research tools can be used by industry to improve the quality and lower the cost of its products.

For example, the X-ray has furnished diffraction patterns that increase our knowledge of the structure of certain materials and more recently the gamma ray has been used with even greater success for this purpose. The technique of microanalysis has been developed, in which, for example, a thimbleful of gas or a solid the size of a pinhead are subjected to complete analysis. Use of molecular beams or of the Raman spectrum produced with the quartz-tube mercury lamp have led to new knowledge of the composition of materials.

In contrast to micro-distillation is the 35-ft. still at the Bureau of Standards that will separate two liquids whose boiling points are only about 2 deg. F. apart. Chemical research has involved temperatures from —457 deg. F. to +6500 deg. F. High temperature control is effected with the photoelectric cell. Uniformity of temperature in a molten mass may be accomplished by electron tubes that stir the liquid by tumbling its molecules over. Pressures ranging from a fraction of a millimeter of mercury to about 3000 atmospheres are employed in some scientific work.

These are some of the new tools of modern research discussed at a recent American Chemical Society meeting, as reported by the Industrial Bulletin of Arthur D. Little, Inc. In reading them over quickly, can you decide where chemistry stops and electrical engineering begins or where mechanical engineering stops and pure physics begins? Or which is pure science and which is engineering?

No, the sharp dividing lines are gone. Nowadays we take all knowledge for our province without any sense of arrogance or assumption of superiority. For we have found that all knowledge is so inter-related that we can take it all through those inter-relations. And with it we are building a new world.

Through at Forty?

Yes, there are careers that end at about the age of forty. The professional athelete—prize fighter, wrestler, baseball player, football player, hockey player, foot racer —reaches the height of his ability and is usually on the decline before the age of forty. Unfortunately many industrial establishments are reluctant to employ, for permanent positions, workers who have reached the forty-five or fifty mark; the brain worker, however, usually has a longer lease on working life for it is seldom that a man in good health reaches the peak of his mental development before the half century mark in his life, provided, of course, he does not cease the training of his mind.

Many of our best engineers in power plants today have come to their positions through apprenticeship training in some trade, supplemented by extension school work which has placed them in possession of a fundamental knowledge sufficient to make them extremely valuable as power engineers, valuable even to the ripe old age of 70 years.

While at one time their duties may have required extreme skill, dexterity and endurance of muscles, as the directing head of a power plant or even the department of a plant, the most valuable features of their work are mental rather than physical. For this reason engineers, as a rule, have a much longer useful career than the worker who has limited his occupation to labor depending principally upon muscular skill.

One of our prominent engineering associations recently decided to abandon an intensive educational program, stating as one of the reasons for such an action that an investigation revealed that the average age of its members is above forty years and that a majority have little interest in any form of individualized education. The action on the part of the association probably was wise as when men reach such an age of maturity they have or should have very definite plans for informing themselves along the lines in which their greatest interest lies which are, more than likely, highly special and would not fit in well with others. To cease sys-

tematic study and allow the mind to drift without purpose at the age of forty is, it seems to us, the height of folly particularly for engineers many of whom by that time have not completed half their professional career. When an individual ceases to make himself more valuable his advancement is at an end.

Through at forty? No, not engineers.

Purchasing Power to the Best Advantage

Many industrial plants generate some power and purchase the balance from the utility company. Sometimes the generating equipment is operated in parallel with the utility system, sometimes it carries a portion of the load on a separate circuit.

In either case it is extremely important that each system be operated or divided so as to give the lowest total cost and as the operation of each part affects the other this proper operating point is difficult to determine. Peak loads unduly penalize purchased power because of the demand charge and the operation of a 100-kw. load for 15 or 20 min. at an ill advised moment may add from $175 to $225 to the month's power bill for use of only 25 or 30 kw. hr. actual peak energy.

For this reason it is advisable always to have the total plant generating equipment in service and loaded during peak load so as to lessen the demand charge. If this is not possible, demand limitations should be installed so that they will cut out, for a few minutes, some of the non-essential load at a predetermined load. For instance, with a demand based on a 15-min. peak, air compressors might be arranged to be stopped for two or three minutes after the predetermined peak load has been exceeded for 14 min.

If the load is not dropped in this way, provision must be made for carrying the excess on the plant generating equipment which, under usual conditions, is probably operated on the basis of the demand for the exhaust steam. Under normal load conditions, it is evident that at times some live steam must be used in the process lines and at other times some of the prime mover exhaust must be wasted to the atmosphere or to the condenser.

Determination of the proper operating methods is difficult and complicated but in this issue Mr. Wallene tells how one plant solved the problem nicely. Steam and electric load curves are shown, the arrangement including a dual drive on a large refrigerating unit. Sometimes the motor would carry the load, sometimes the engine would carry it, sometimes the load would be divided between them, while at other times the engine carries the refrigerating load and in addition drives the motor as a generator to cut down the purchased power bill. In this case the load control is entirely automatic, actuated by the steam load and the predetermined demand. The method can be used to advantage by so many plants that the article is worth serious study by all industrial plant engineers.

The Modern Cyclops

Classical mythology tells of a race of giants having only one eye who were said to have lived in Sicily a long time ago when giants were not altogether an uncommon phenomenon. According to some legends these one-eyed giants were shepherds—other fables had them assisting in the workshops of Vulcan, but whatever they were, their single eye must have been a conspicuous feature of their personality for legends of it have come down through the ages. According to some the eye was luminous and in "Forty Singing Seamen" Alfred Noyes tells of—"his battered moon eye gleaming, red and yellow in the dark."

Today we take little stock in these legends and we have in our midst a new Cyclops—a new giant with a single red eye whose powers far outshine those of the giants of old. This giant, however, is a giant only in his potential capabilities, for in stature he is a pygmy. He belongs to the family of vacuum tubes, so long considered to be delicate creatures of little consequence until brought into prominence by radio.

The name of this new giant is the photo-glow tube, a blood relative of the grid-glow tube. It was developed to meet the need for a device sensitive to light which could handle currents far in excess of the usual photo-electric tubes. There are many applications such as controlling lights or manufacturing processes setting off alarms, and counting, where a device is needed which will close or open a circuit depending upon the interruption or formation of a light beam and which will pass sufficient current to operate control devices directly without the use of intermediate amplifiers. The photo-glow tube does this and, moreover, does it rapidly.

Although these tubes are still in the laboratory stage, a number of them have been in use in this field for as long as two years. One of these applications is particularly interesting for it is used to guard a direct current generator against flashover. Mounted on the bedplate of the machine they have kept a sleepless eye on the commutator so that if a flashover occurred, the control circuit would be instantly and automatically operated. Another group of these glow tubes is installed behind a large switchboard where it keeps an ever watchful eye on the buses.

So fast is this modern cyclops that when an arc or a flashover on a commutator starts to form, the tube will act to operate the control circuits, before the arc bridges over. In other words, providing there is no lag in the control circuits, the photo-glow tube will interrupt the arc before it actually occurs.

ACCORDING to census figures only one-half of 1 per cent of the manufacturing establishments in the United States employ over 1000 wage-earners; only 1.4 per cent employ over 500; and only 3.4 per cent employ more than 250.

Still more surprising are the figures relating to the number of wage-earners employed by these groups of plants. The one-half of 1 per cent employing over 1000 wage-earners employ in the aggregate nearly one quarter of the total number of wage-earners in manufacturing industry. Nevertheless, plants that employ 500 or fewer workers employ collectively 61.9 per cent of the total. If an even more strict interpretation is placed on the question of what constitutes a small plant and establishments that employ not more than 100 workers are considered, it is found that 87.2 per cent of manufacturing establishments fall within this group and that the 28.8 per cent of wage-earners employed by them constitute a larger number than the 24.1 per cent employed by the large establishments with more than 1000 workers.

Power Plant Engineering Developments and News

Thor Spray Gun Model Two

FOR ATOMIZATION and application of finishes from thin priming coats to heavy bodies lacquers and enamels, Binks Manufacturing Co., Chicago, has developed the Model 2 Thor gun, which can be changed from flat to round spray, without stopping operation or resetting of nozzle. This change is controlled by a screw on the back above the handle, which in the standard type is operated by the user but may be set by the production foreman by means of a removable key, when the spray will remain unchanged during use.

First pull of the two-finger trigger passes an air jet for cleaning the surface to be painted; further pull allows paint to flow in the size spray desired, according to the pull exerted. Connection of the air to the handle and paint supply near the nozzle gives balance in the hand of the operator. Self centering of the air nozzle keeps it in alinement with the fluid tip for all sizes of round or flat spray so that no adjustment is needed. Air ports have clear passage, which avoids clogging and permits quick, easy cleaning. As no paint comes in contact with springs or air control parts, disassembling for cleaning is unnecessary.

Materials used are, for the body drop-forged steel of 62,000 lb. tensile strength, die-cast handle, for fluid nozzle stainless steel with stainless steel alloy needle valve stem, for air nozzle drop-forged bronze.

Nozzles are proportioned for the specific work to be done, the same kind being used for syphon cup and for gravity feed, using 40 to 60 lb. air pressure. For pressure feed containers, nozzles are modified to give best atomization and speed. Method of supplying paint and air capacity available should, therefore, be stated when ordering.

THOR MODEL 2 SPRAY GUN

Centrifugal Pump for Solid-Carrying Liquids

FOR LIQUIDS carrying solids which tend to cause clogging, pumps should have large, open and direct passages. Narrow clearances or working joints between impeller and casing and around the shaft are unavoidable but should be so designed as to reduce or eliminate the entrainment of solids. Heavy substantial construction, a firm support of running parts and correct hydraulic design of the impeller passages and of the casing volute, with smooth finish are required for high efficiency.

Shown in the accompanying illustrations is the Clogless pump which has been developed by the De Laval Steam Turbine Co., Trenton, N. J., for handling sewage, paper pulp and similar liquids. The casing cover can be lifted off without disturbing the discharge pipe connection and after only partial unbolting of the suction pipe connection. All internal parts and passages are then accessible and, after loosening the bearing cap, the rotating element, with bearings, can be lifted out. A large handhole, with easily removable cover, is located on the cover half of the suction nozzle, to give quick access to the suction side of the impeller for inspection and cleaning.

Cast integral with the lower half of the pump casing, is a pedestal or supporting foot, designed to be bolted directly to the bedplate of motor or engine-driven units. The pump volute or body is overhung, making the piping connections easily accessible.

Passages through the impeller, both between the side plates and between the vanes, are extra wide. Ordinarily two vanes are used, proper guiding of the

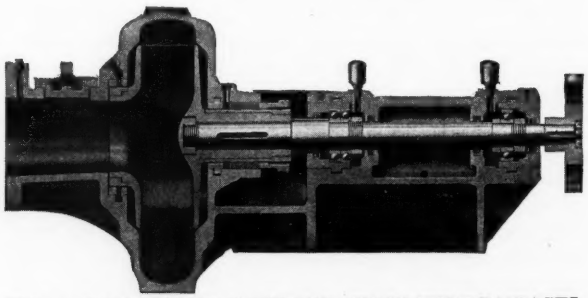


FIG. 1. CLOGLESS PUMP SECTION SHOWS WIDE PASSAGES, PROTECTION FROM WEAR AND SUBSTANTIAL MOUNTING

liquid without cavitation or shock being attained by suitable selection of the speed and of the impeller diameter. Where the pump capacity or the nature of the liquid permits, the number of impeller blades is increased to three or four, permitting of higher speed.

At the joint between the impeller and casing, the impeller is protected by a bronze ring threaded upon it, while the casing is protected by a stationary bronze ring seated in a recess formed in the casing and cover, hence removable when the cover and rotor are lifted.

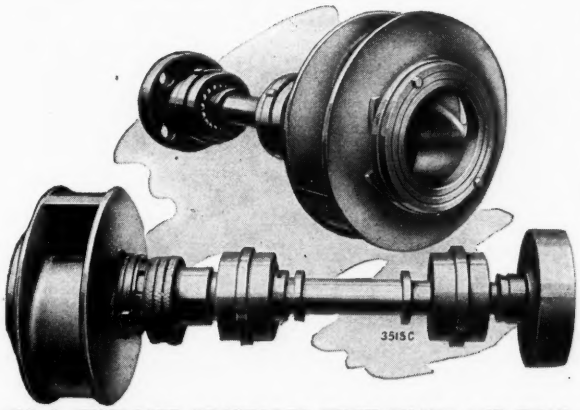


FIG. 2. ENCLOSED PROPELLER WITH SHAFT AND BEARINGS, REMOVABLE AS A UNIT

A circumferential slot in the stationary ring communicates with a tapped opening through the casing cover to provide for sealing with clear water under a pressure slightly higher than that generated by the pump, in order to prevent liquid and abrasive matter handled by the pump from entering between the rings.

For some services an open impeller is used, with removable stationary side plates of special form held in recesses in the pump casing and cover to guide the liquid during its passage through the impeller. The knife-like edges of the impeller blades, running close to these side plates, cut or shear stringy material. Efficiencies obtained are nearly equal to those of enclosed impellers.

To reduce overhang of the shaft, the stuffing-box is located over the impeller hub, which is protected by a renewable bronze sleeve. A tapped opening in the casing cover provides for the introduction of clear-sealing water at a pressure slightly higher than that of the pump, thus preventing the entrance of solids to the soft packing.

Next to the impeller a ball bearing is used of duplex type, arranged to take all unbalanced thrust, including the weight of the impeller and shaft when the pump is installed with the shaft vertical. The outer bearing is single row, intended to take radial forces only, the outer race being slideable, to prevent binding due to any inequality in expansion of shaft and pedestal. A flexible coupling which will transmit no thrust and which allows for unavoidable misalignment is used to connect the pump shaft to the driving shaft, the pump half of the coupling being mounted upon a taper fit to permit easy removal.

For vertical shaft operation, this pump is constructed as for horizontal operation, the thrust bearing being heavy enough to take the additional load imposed by the weight of the rotor. The pedestal or foot of the pump can be bolted to vertical I-beams, or channels, involving no change whatever from the horizontal design, or a semi-circular foot for supporting the pump on the floor can be cast as part of the casing.

Improved Hand and Hydraulic Pipe Benders

FOR BENDING AND STRAIGHTENING cold pipe, tubes and conduit, the "Chicago" benders made by Gustave Lidseen, Inc., Chicago, Ill., should be of interest to those handling pipe from ½ to 4½ inches. The No. 1 Hand bender shown in Fig. 1 is sturdily constructed and has no attachments to change. It is easily attached to a bench, post, or to the stand shown in the illustration. It has two operating handles, No. 1, used for ½ and ¾-in. pipe while No. 2 is for 1-in. pipe.

The No. 4 Chicago 30-ton hydraulic bender shown in Fig. 2 will handle eight sizes —1¼ in. to 4½ in. inclusive. It will make any and all necessary bends

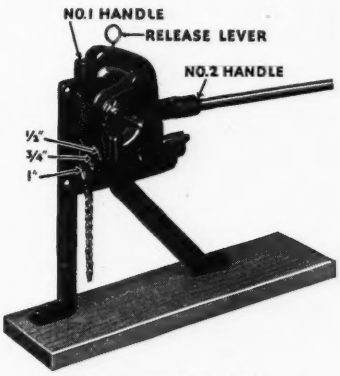


FIG. 1. CHICAGO HAND PIPE BENDER

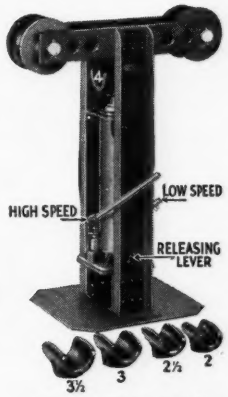


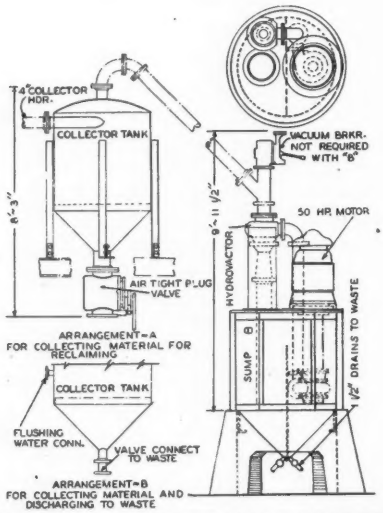
FIG. 2. THIRTY TON HYDRAULIC BENDER

or offsets with ease and safety. The rollers are of a special new type, spaced for different size pipe and will handle all eight sizes without change of rollers. The shoes are made of cast steel and only one shoe is required for each size pipe. The necessary time for changing shoes and adjusting rollers for different bends and different size pipe is approximately one second. This bender weighs only 310 lb., less equipment and is easily transported from place to place.

Hydrovacuum Unit

NEW HYDROVACUUM UNIT shown herewith consists of a Hydroseal pump which delivers water at high pressure through a Hydrovactor, discharging through a nozzle ring and thereby creating a high vacuum. The water discharges into a sump tank and is used over and over again. The unit is built to handle between 10 and 15 t. of fine material an hour through a 4-in. header and the material may be discharged dry as shown in arrangement A or wet as in arrangement B.

Various applications of this unit are suggested by its manufacturer, the Allen-Sherman-Hoff Co. of Philadelphia, Pa. It is designed to be applied to soot handling by the application of standard A-S-H wind-swept valves beneath the soot collection hoppers. The refuse can be discharged wet or dry. By placing wind-swept-valves beneath the siftings hoppers and the cyclone collector tank above the coal bunker, siftings can be returned to the furnace to be burned. By the application of standard A-S-H vacuum cleaning nozzles, the



ARRANGEMENT A OF HYDROVACUUM UNIT IS USED FOR HANDLING MATERIAL DRY WHILE ARRANGEMENT B IS FOR WET DISCHARGE

unit can be used for cleaning plant floors and walls. The high vacuum, it is claimed, assures efficient cleaning at outlets remote from the unit.

By using A-S-H wind swept valves beneath bins, various raw materials can be conveyed to the collector. Likewise by using special portable nozzles, the unit can be used for unloading cars, barges or ship holds of loose materials.

Air-Operated Recorder Controller

LINE of air-operated recording controllers, employing a free vane as the initiator of control, stated to be a new departure in air-operated control, has just been placed on the market by The Bristol Co., Waterbury, Conn. The free vane is attached to and actuated by a measuring element of a temperature or pressure recording system and moves between two air jets with stream lines coinciding placed opposite each other. In passing into these air streams, the free vane varies the amount of air which escapes from the jets, thus effecting control. The component parts are made to be easily accessible although compactly assembled. The point of control is set to a visible scale point by a key.

In the operation of the controller, shown in the sketch, air at 15 lb. pressure is admitted through connection (7) and carried through filter (8), one branch leading to an indicating gage (9). The other branch turns to the left and supplies air to the control system. This supply branch in turn divides into two branches. One passes through an orifice (10) supplying the elastic element (11) and then through a connecting line to the opposing jets (5) and (6). The other branch supplies air to the pilot valve (12) and through the pilot valve to the indicating gage (14) and outward to the top of the diaphragm motor valve (13).

The air which enters through orifice (10) is dissipated through jets (5) and (6). The amount which may be dissipated through these jets depends upon the position of the free vane (4). This vane, being directly attached to an elastic element (1) of the hollow helical type, is moved by changes in the temperature at the sensitive bulb shown in the bath at the lower right-hand corner. The changing amount of dissipated air at jets (5) and (6) produces a pressure change on the elastic element (11) and a consequent deformation which operates pilot valve (12) admitting more or less air to the top for operating the diaphragm motor valve (13). The elastic element (1) also carries the recording pen-arm which is attached to the shaft (3).

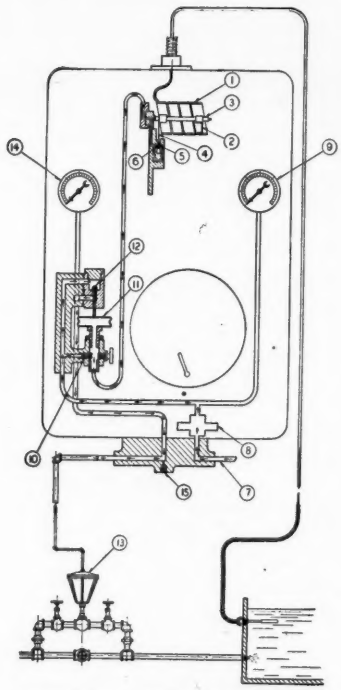


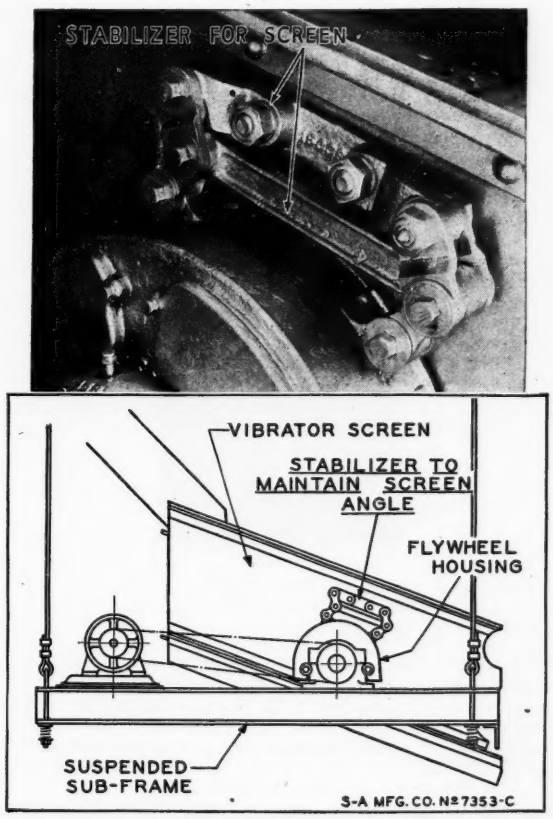
DIAGRAM SHOWING OPERATION OF FREE-VANE RECORDER CONTROLLER

The recorder controller is enclosed in a two-part cast-aluminum case of moisture-proof construction. It is furnished with inverted penarm and fountain pen as standard equipment. The chart is rotated by a powerful spring clock or by Bristol's telechron operated clock. The case is available for wall or flush mounting, furnished as a single or two-pen instrument in combination of pressure or temperature and has a pressure range up to 1500 lb. per sq. in. and temperature range up to 1000 degrees F., using 12-in. charts. Temperature measuring systems may be either vapor or gas-filled, depending on the operating temperatures encountered.

THE FAMED PILLAR of Delhi is a shaft of pure wrought iron erected about 400 A. D. and today one of the leading sights of the Indian City.

Stabilizer Mounting for Vibrator Screens

IN THIS NEW mounting, developed by Stephens-Adamson Mfg. Co. of Aurora, Ill., the balancing springs heretofore used to hold the screen body at the proper screening angle yet permit the screens to be given a vibrating motion have been replaced by a single unit "stabilizer" which is mounted on one side of the screen so that the screen body can vibrate freely with the eccentric shaft yet cannot be rocked or bounced by sudden surges of material over the screen. The screen



STABILIZER MAINTAINS SCREEN ANGLE YET PREVENTS ROCKING

body can be quickly shifted to a new angle simply by loosening two bolts on one side.

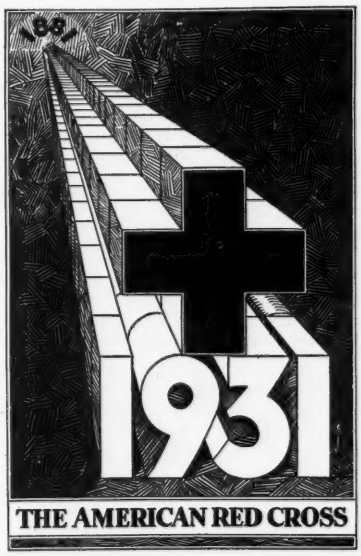
This stabilizer consists of two pairs of short arms, as shown in the illustration, each jointed in the middle and held parallel by a heavy cross bar. One end of each arm is pivoted on the flywheel housing, which is solidly mounted on the heavy, spring-suspended sub-frame. The other end of each arm is free to swing in a shackle in the screen body in any direction but both must act together. Movement of the arms is slight, even in screens having a long throw, hinge pins being equipped with automatic oil feeders to ensure good lubrication and free movement.

HYDROGEN cooling of synchronous condensers increases the output from 25 to 30 per cent above that of air cooling.

Red Cross Helps After Disaster

IT HAS BEEN well said that the Red Cross is America's assurance of relief in disaster and that its peace-time services contribute to the maintenance of a high standard of living for the community. In time of disaster, many public works are in the paths of destruction. Then communities find themselves without lighting facilities, with water works either wiped out or drinking water so polluted as to be unfit for use. The American Red Cross has gone into the debris of disaster to dig a city out and back to life and activity.

In time of disaster, the Red Cross is first on the scene. In recent years, its equipment has expanded with the ever increasing demand. Even the airplane has become the wing of humanity, bringing medical and



emergency supplies to the disaster victims when no other route into the wrecked area is passable. First aid and emergency hospitals are quickly set up and, in extensive disasters where hospitals would be overcrowded, the emergency medical units stay on the scene until the patients can be properly cared for through the existing channels of hospitalization and medical provision.

In more than 3500 cities and towns, the Red Cross local chapters are serving their communities ready for duty at every call in the daily life of the people and when great calamity brings sudden destruction. The Chapter is the community link in the great Red Cross chain encompassing the whole country. In a single year, 100,000 deaths and several million injuries occur in the United States from accidental causes. The Red Cross is seeking to reduce this number by a campaign of instruction in first aid. Red Cross membership gives each person a share in the support of this service as well as all other activities of the Red Cross.

Observance of the Golden Anniversary of the American Red Cross this year marks that society's fiftieth year of service to humanity. Do your bit by joining.

DUST ACCUMULATION on a shaft may draw oil from the bearings by capillary action.

News Notes

SHEPARD NILES CRANE & HOIST CORP., Montour Falls, N. Y., announces that its Chicago sales office was moved on October 1, 1931, to 564 West Monroe St., Chicago, Ill. The new telephone number is Franklin 2720.

PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., has formed a connection with Byer Engineering Associates, of the same city, with branch offices at 136 Liberty St., New York and 1328 Chestnut St., Philadelphia. Henry E. Byer, head of Byer Engineering Associates, has specialized for the past 20 years in the manufacture, application and operation for vacuum apparatus while connected with the Ingersoll-Rand Co. and Chicago Pneumatic Tool Co.

BAILEY METER CO., Cleveland, Ohio, announces the location of sales engineers in two southern cities. M. J. McWhorter, who formerly made his headquarters at 39 Fairhaven Circle, Atlanta, Ga., is now located at 1708 Euclid Ave., Charlotte, N. C. Mr. McWhorter continues as manager of the Southern territory, and is assisted by J. H. Whittlesey, who has headquarters at 3201 Carlisle Road, Birmingham, Ala.

MILLION-DOLLAR CONTRACT for installing elevators in the new Marshall Field office building in Chicago has just been awarded the Otis Elevator Co. This contract calls for the installation of fifty of the most modern type automatic signal control elevators. The entire equipment, including de luxe elevator cabs, designed by Graham, Anderson, Probst & White, architects for the building, will be manufactured and installed by the Otis company.

BARBER-GREENE CO. of Aurora, Ill., announces the appointment as general sales manager of F. D. Hooper, formerly sales manager of the Lidgerwood Manufacturing Co. of Elizabeth, New Jersey.

DAMPNEY CO. OF AMERICA, Hyde Park, Boston, Mass., announces the appointment of Clarence J. Hunter to the position of general sales manager with headquarters at Hyde Park. Mr. Hunter was formerly manager of the Philadelphia branch office.

MELVIN SACK, formerly connected with the C. H. Wheeler Manufacturing Co. of Philadelphia, Pa., specializing in heat exchangers, has joined the engineering staff of the Henry Vogt Machine Co. of Louisville, Ky. Mr. Sack assumes charge of the department of heat exchanger design.

WILLIAM T. BENTZ has been appointed manager of sales of rail steel products, according to a Republic Steel Corp. announcement made by N. J. Clarke, vice-president in charge of sales. In his former capacity as sales head of Steel and Tubes, Inc., a Republic subsidiary, Mr Bentz had many years' experience with the manufacture and sale of hard steel products. He will continue for the present to make his headquarters in Cleveland.

MAINTENANCE ENGINEERING CORP., 1400-2 Conti St., Houston, Texas, announces that it has recently made arrangements to represent the Mason Regulator Co. of Boston, Mass., in this territory.

HARRY L. ERLICHER, who entered the employ of the General Electric Co. as an office boy in the purchasing department, has been appointed purchasing agent, succeeding L. G. Banker, who retired on October 1 after completing 43 yr. continuous service with the company. Mr. Erlicher did not remain long as office boy. He soon advanced to a clerical position, in 1910 was appointed a buyer and in 1923, when the position of assistant purchasing agent was created, he was selected for the place. In his new position, Mr. Erlicher will direct purchases of materials aggregating more than $100,000,000 a year.

F. E. FLEMING has been appointed sales engineer at the Chicago office of the Riley Stoker Corp., Worcester, Mass. R. L. Sauer has been appointed district manager at the Detroit office. The Corporation announces the appointment of M. L. Cornelius as district manager at Cleveland, Ohio, of I. W. Lachman as sales engineer at the New York office and of W. J. Ehmer as sales engineer at the Philadelphia office.

INSPIRED BY the success of the 500-hp. fire-tube boiler operated from waste gases from one of its open hearth furnaces, installation of which was completed early in May, this year, Central Iron & Steel Co., Harrisburg, Pa., is now completing the installation of two duplicate units.

The boilers which furnish steam for operation of rolling mill engines are 22 ft. long and 9 ft. in diameter, each equipped with 470 tubes 2½ in. in diameter. Large fans exhaust the open hearth gas through the boilers at high velocity while the steam is carried to the mill engines through a recently constructed 12-in. steam line 2450 ft. long. Prior to the first installation, the company had successfully employed 9 fire-tube waste heat boilers of 150 hp., operated in conjunction with its heating furnaces.

ORROK, MYERS & SHOUDY is the name adopted by a group of consulting engineers with offices at 21 E. 40th St., New York City, formed for special work in power and steam engineering. The principals in the group are Geo. A. Orrok, David Moffat Myers and W. A. Shoudy, familiar to our readers from their articles in Power Plant Engineering. Associated with them are Percy H. Thomas in New York City, Frank B. Steele in Utica, N. Y., and Osborn Monnett in Chicago.

CHICAGO PNEUMATIC TOOL CO. announces the removal of its office and service station at Seattle, Wash., from 1743 First Avenue South to 3201 First Avenue South and the appointment of C. Kirk Hillman as district manager.

SIMULTANEOUS ANNOUNCEMENT has been made by the Westinghouse Lamp Co. and the Electrical Association of New York of the acquisition by the latter of the Westinghouse Lighting Institute in Grand Central Palace, effective October 1, 1931.

F. J. GRIFFITHS has joined The Timken organization at Canton, Ohio, being elected director and president of The Timken Steel and Tube Co., M. T. Lothrop, president of The Timken Roller Bearing Co., being made chairman of the board of The Timken Steel and Tube Co.

Until recently, Mr. Griffiths was associated with the Republic Steel Corp. as president of the Republic Research Corporation.

He began his career in the steel industry with the United Steel Co. at Canton, later helping to organize The Central Steel Co. in Massillon, Ohio, of which he was president and general manager. When these two companies were merged to form The Central Alloy Steel Co., he was chosen chairman of the board, which office he held until the Central Alloy merger with Republic.

AFTER ABOUT a year and three-quarters as manager of sales of the Paradon Co., Francis D. West has returned to The Permutit Co. as district sales manager with headquarters at 712 Brisbane Building, Buffalo, New York. Mr. West was associated with The Permutit Co. from 1918 until 1930.

D. W. PEABODY, for the past 25 yr. with the Southeastern district office of the General Electric Co. in various engineering, sales and executive capacities, announces the opening of consulting engineering offices at 588 Linwood Avenue, Atlanta, Ga. Mr. Peabody will specialize in mechanical and electrical engineering—making surveys—submitting reports, developing designs and layouts, supervising construction, process and operation, and serving in a general consulting capacity.

INTERNATIONAL-STACEY CORP., Columbus, Ohio, announces the purchase of all the stock of the Stacey Manufacturing Co. of Cincinnati, Ohio. Col. Carmi Thompson, president, A. A. Ranshaw, vice-president, H. M. Runkle, secretary and treasurer and E. J. Baechle, assistant secretary and treasurer, will head the Cincinnati group, which will be known as the Stacey Gas Construction Division of International-Stacey Corp. Management will be directed from the executive offices in Columbus.

ALBERT JEFFERSON SAYERS, engineer with Link-Belt Co., 61 years old, passed away at his home 7121 Eggleston Ave., Chicago, on Sunday morning, October 11th, at eleven o'clock. Mr. Sayers was head of the Coal Tipple and Coal Washery Department of Link-Belt Co., Chicago, and was recognized as one of the leading designers of this type of equipment.

Born September 10, 1870, at Troy, Ohio, and educated at the University of Illinois, he was graduated in the Class of 1895, joining the Link-Belt organization in 1899 and for 32 years being affiliated with that company, Mr. Sayers was a member of the A.S.M.E., the Manufacturers Division of the American Mining Congress, and other engineering organizations.

Books and Catalogs

HEATING AND VENTILATION, by John R. Allen and James Herbert Walker, with a chapter on Hot-water Heating Systems by F. E. Giesecke, third edition, McGraw-Hill Book Co., Inc., New York, 1931, price $4.00.

In this third edition of Heating and Ventilation, material on artificial cooling and industrial air conditioning has been added and nearly all of the chapters have been enlarged. This, with the addition of the chapter by Professor F. E. Giesecke, has brought the book up to date since the last edition, eight years ago. Previous editions have been used to quite an extent in engineering schools as well as by practicing engineers in the heating and ventilating field and the present edition has been prepared to meet both of these needs. During the past decade, a great amount of research work has been done in the heating and ventilating field and much of the results of research conducted by the American Society of Heating and Ventilating Engineers and university experiment stations has been incorporated in this third edition.

HANDBOOK OF OIL BURNING, by Harry F. Tapp, published by the American Oil Burner Association, 342 Madison Ave., New York, 1931.

Recognizing that many mistakes have been made in the installation and use of oil burning equipment, the American Oil Burning Association presents this handbook, prepared by its executive secretary, Harry F. Tapp, to give facts and authoritative information pertaining to oil burning in industrial, power plant and domestic furnaces. Although put up in handbook form this volume is a combination of textbook with the addition of curves, tables, charts and diagrams which make the book not only interesting reading but valuable in the solution of problems dealing with the combustion of oil.

SINGLE-STAGE, double-suction, centrifugal pumps of the horizontally-split-casing design are fully described and illustrated in detail in a leaflet recently published by the De Laval Steam Turbine Co., Trenton, N. J.

MODERN STEAM is the subject of a new bulletin outlining the evolution of marine steam propulsion. The bulletin also deals with the economies of steam propulsion from the standpoint of fuel consumption, cost of fuel, lubricating oil costs, flexibility of operation and other important factors. The booklet is written in non-technical style and clearly explains the economic fundamentals of ship propulsion. It is profusely illustrated with photographs of modern marine installations. It is published by The Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.

RETURN BEND ECONOMIZERS is the subject of a new bulletin issued by The Babcock & Wilcox Co., 85 Liberty St., New York. This publication describes a forged-steel, return-bend type economizer in which all the latest features of design have been incorporated and which is designed to provide a high rate of heat transfer with freedom from expansion strains. All the details of the economizer, such as the return bends, headers, tubes, casing, are fully described and illustrated by photographs and drawings. Typical installation views and setting plans are shown, to demonstrate the adaptability of the economizer to various types of boilers.

CHAIN GRATE STOKERS is the subject of a new bulletin issued by The Babcock & Wilcox Co., 85 Liberty St., New York. The booklet contains full descriptions of the various types of stokers with suitable photographs and line drawings to illustrate each type. Typical setting views are shown, demonstrating the adaptability of the stokers to various types of boilers. The bulletin is attractively bound and illustrated in colors.

K. W. S. WATER TESTING EQUIPMENT for laboratory and power plant use, including glassware, small cabinets, Nalco stirrers, Nalco evaporators, Nalco water samplers, standard solutions, together with instructions for testing water are completely discussed and illustrated in a 12-page, letter-size bulletin just issued by National Aluminate Corp., 6216 W. 66th Place, Chicago, Ill. This company is also issuing reprints of a paper on Prevention of Silica Scale with Sodium Aluminate, by C. H. Christman, J. A. Holmes, and H. Thompson, all of National Aluminate Corp., presented before the April 1 meeting of the American Chemical Society at Indianapolis.

NEED FOR GREATER speed in steamships to meet competition and to benefit from mail subsidies is leading to reconditioning a number of ships built during or soon after the World War. Work done on the City of Baltimore in equipping it with De Laval compound, double-reduction-geared turbines for 250-lb. steam at 100 deg. superheat also De Laval turbine drive for American Blower draft fan, De Laval boiler feed pumps, Worthington condensers and pumps and Babcock & Wilcox oil-burning water-tube boilers is described in a leaflet issued by De Laval Steam Turbine Co., Trenton, N. J. Speed was increased from 10½ knots to trial average of 17.77 knots and maximum of 18.01 knots. Fuel consumption of bunker oil for all purposes worked out to 0.74 lb. per shaft horsepower.

BINKS WATER-COOLING equipment including, ponds, spray and deck towers, spray louvre fencing and spray nozzles are fully illustrated and described with capacity and dimension tables in a 34-page catalog, Bulletin No. 6-E, issued by Binks Manufacturing Co., 3107-46 Carroll Ave., Chicago, Ill. Data are given for determining the cooling effect for any set of conditions, spacing for spray nozzles, best pressures to use, how to test cooling installations and uses of nozzles for industrial applications such as air washing, atomization, water aeration and washing of sand filters.

VORTICOSE DUST COLLECTOR, its construction, principles of operation and applications are described in a well-illustrated, letter-size bulletin just issued by Dust Recovery, Inc., 15 Park Row, New York, N. Y.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of Power Plant Engineering, published semi-monthly at Chicago, Ill., for October, 1931.

State of Illinois, } ss.
County of Cook, }

Before me, a Notary in and for the State and county aforesaid, personally appeared Arthur L. Rice, who, having been duly sworn according to law, deposes and says that he is the Editor of the Power Plant Engineering and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher, Technical Publishing Co., Chicago, Ill.
Editor, Arthur L. Rice, Chicago, Ill.
Managing Editor, R. E. Turner, Chicago, Ill.
Business Manager, E. R. Shaw, Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)
Technical Publishing Co., Chicago, Ill.
E. R. Shaw, Chicago, Ill.
Madge W. Rice, Wilmette, Ill.
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3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)
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4. That the two paragraphs next above giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but, also, in cases where the stockholder or security holder appears upon the books of the company as trustees or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

TECHNICAL PUBLISHING CO.,
ARTHUR L. RICE, Editor.

Sworn to and subscribed before me this 25th day of September, 1931.
[Seal.]
EDDIE H. KAHL,
Notary Public.

(My commission expires March 20, 1932.)

Machinery, Equipment and Supplies Used In The Production, Transmission and Utilization of Power

Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear

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Wing Mfg. Co., L. J., New York.

BLOWERS, Tube
Bayer Co., The, St. Louis, Mo.
Diamond Power Spec. Corp., Detroit, Mich.

BLOWERS, Turbine
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Stephens - Adamson Mfg. Co., Aurora, Ill

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Kennedy-Van Saun Mfg. & Engrg. Corp., New York, N. Y.

To Find the Manufacturers' Advertisements of Products Listed Here, See Index Page 98

Permutit Co., New York, N. Y.

CHIMNEYS
American Chimney Corp., N. Y.

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Dearborn Chem. Co., Chicago.

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Brown Instr. Co., Philadelphia.
Hays Corp., Michigan City, Ind.
Leeds & Northrup Co., Phila.
Permutit Co., New York, N. Y.
Pierce Co., Wm. B., Buffalo.
Republic Flow Meters Co., Chicago, Ill.

COMBUSTION CONTROL SYSTEM
Bailey Meter Co., Cleveland.
Engineer Co., The, New York.
Leeds and Northrup Co., Phila.

COOLERS, Air, Oil and Water
Wheeler Mfg. Co., C. H., Phila.

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COOLING TOWERS
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Schubert-Christy Corp., Affton, Wheeler Mfg. Co., C. H., Phila.

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Terry Steam Turbine Co., Hartford, Conn.

COUPLINGS, Turbo
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COUPLINGS, Union
Dart Mfg. Co., E. M., Providence.

DE-AERATORS
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DESUPERHEATERS
Babcock & Wilcox Co., N. Y.
Elliott Co., Jeannette, Pa.

DRYERS, Coal
Kennedy-Van Saun Mfg. & Engrg. Corp., New York, N. Y.

DRYERS, Rotary & Waste Heat
Fuller Lehigh Co., New York, N. Y.

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EJECTORS
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Wachs Co., E. H., Chicago.

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Ruggles-Klingemann Mfg. Co., Salem, Mass.
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Schubert-Christy Corp., Affton,

FANS, Exhaust and Ventilating
Wing Mfg. Co., L. J., New York.

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Elgin Softener Corp., Elgin, Ill.
Permutit Co., New York, N. Y.

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Elliott Company, Jeannette, Pa.
Foster Wheeler Corp., New York.
Hoppes Mfg. Co., Springfield, O.
National Pipe Bending Co., New Haven, Conn.
Scaife & Sons Co., Wm. B. Oakmont, Pa.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., New York.

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Dearborn Chemical Co., Chicago.
Elgin Softener Corp., Elgin, Ill.
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Permutit Co., New York, N. Y.
Scaife & Sons Co., Wm. B., Oakmont, Pa.

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Burt Mfg. Co., The, Akron, O.

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Permutit Co., New York, N. Y.
Scaife & Sons Co., Wm., B. Oakmont, Pa.

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FITTINGS, Ammonia
Frick Co., Waynesboro, Pa.

FITTINGS, Flange and Pipe
Kennedy Valve Mfg. Co., Elmira, N. Y.
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Reliance Gauge Column Co., Cleveland, O.

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General Specialty Co., Buffalo.
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FURNACE WALLS
Combustion Engrg. Corp., N. Y.

FURNACES, Boiler
Kennedy-Van Saun Mfg. & Engrg. Corp., New York, N. Y.

FURNACES, Pulverized Coal
Kennedy-Van Saun Mfg. & Engrg. Corp., New York, N. Y.